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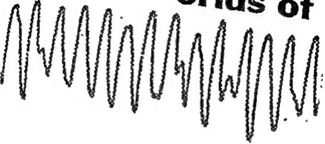

A TREASURY

EDITED BY LEONARD ENGEL

from the Foreword by Leonard Engel

"My object has been to select articles o papers that tell, as simply as reasonably sible, something of what modern science doing, what scientists are interested in, a how they work—in short, what modern ence is about."

about the Editor

One of America's most experienced writ on science, Leonard Engel has pioneered the field of popularization for the layman the last twenty years. He is probably the m outstanding popular writer in the field tod

Mr. Engel is a regular contributor of sci tific articles to *The New York Times* a *Harper's Bazaar,* and frequently publis articles in other top American and inter tional journals. He was awarded the Geo Pope Memorial Award in 1953, for dis guished journalism in science and medici

Contents

Editor's Preface

Anthologies are often billed as offering the reader the "best" writings of their kind to be had, whatever that kind may be. Aside from the fact that such claims are too presumptuous for my taste, a description of this anthology as a collection of "best" writings on science would miss the mark. I haven't tried to pick the "best" writings on science. My object has been to select, instead, articles and papers that tell, as simply as reasonably possible, something of what modern science is doing, and what scientists are interested in and how they work—in short, something of what modern science is about.

Most of the selections are from the writing of professional scientists. The reason for this is simple. Scientists are not often able to write understandably about science. But when they can, they are apt to be much better at it than professional writers. They know their subjects better. They are not gushingly naïve about science (though they may be as naïve about other matters as the rest of us).

Of course, scientists have not written good popular articles about every interesting aspect of modern science. So I have not hesitated to use the work of journalists when that seemed best.

A casual glance through the table of contents will disclose the omission of many interesting fields of scientific work. This is due mainly to the impossibility of compressing so vast an enterprise as modern science into a single book. It is also due, however, to the circumstance that there are important scientific activities of which no one—whether scientist or journalist—has yet given an adequate account that anyone but a specialist could understand. An example is research on photosynthesis, the remarkable process by which green plants convert the energy of sunlight into food. Since World War II, a good deal has been

learned about photosynthesis. Up to the time this book went to press, though, no article or recent work on photosynthesis suitable for the general reader had been published anywhere that I know of. I hope it will be possible to remedy omissions like this in a future edition [illegible]

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to identity. I owe also particular thanks to Mildred Kapilow, who did a most efficient job of arranging permissions; and to Evelyn M. Jensen and Mrs. Paul B. Hoeber, who had the laborious jobs of typing the manuscript and checking copy.

Leonard Engel

JAMES R. KILLIAN, JR.

Introduction

Dr. Killian is President of the Massachusetts Institute of Technology.

Science and its applications are serving our national security and furthering peace in two special ways at this juncture of world affairs. By steadily increasing the power of weapons, it is deterring war; hopefully it may be helping, through the awful power of these weapons, to convince the nations of the world that total war is no longer possible as an instrument of national policy. Today a major thermo-nuclear war would be a war of nearly total destruction for all participants.

The second way in which science is reducing the will for war, and thus helping to increase world security, is by producing at an accelerating rate new means of improving man's lot—his health, his standard of living, his standard of understanding, and his opportunities for spiritual growth. May not the breath-taking possibilities in the peaceful use of the atom so command the energies and imagination of man that he will conclude he can gain more from nature than from fighting? Within the United States this concept has powerfully influenced our national career. As Professor F. S. C. Northrup and others have pointed out, one of the indigenous and controlling concepts of American society is the conviction that we can put nature to work for beneficent social purposes; we can augment our strength by technology rather than by conquest, by isms, or by social panaceas.

Through the conquests of science, not only in such fields as atomic energy but also in all the many burgeoning branches of science, we can multiply man's energy and understanding and

thus his wealth and well-being. If we can do this, may we not also achieve a world revolution that will reduce the ranks of the have-nots and thereby release the tensions that arise from want and despair? May we not really show that Toynbee was right when he predicted that this century could be the "first age since the dawn of civilization . . . in which people dared to think it practical to make the benefits of civilization available to the whole human race?"

In suggesting these possible benign effects of the current outpouring of scientific discoveries and technology, I do not wish to be blind to the duality of this power. It can be used for evil and destruction, as well as for growth and for the benefit of the "whole human race." This is true of all forms of knowledge and power, of which science is only one. The solution is not to [illegible] knowledge from rolling on. Hope lies in all [illegible] spiritual— [illegible]

Today our great problem and opportunity is to let science be [illegible] potential for good. The beneficent [illegible] field to reduce [illegible] face is that sci- [illegible] hemmed in by [illegible] will be lost, its ranks weakened, and its creativity diminished. If American science is to continue to prosper, if it is to continue to attract its proper complement of creative and gifted minds, scientists must combat the notions that science and engineering are incompatible with the disciplines of the great humanities, that they are narrowly materialistic and destructive of human values.

We live in a period marked by both subtle and gross assaults on intellectual life. The whole domain of science has been represented as endangering man's nobler aims and ends. In the face of the practical responsibilities which rest in science for our security and our material welfare, it is all too easy for people to become bemused by the sophistry that science is inimical to the spiritual ends of life. They fail to understand

make this true character of science better understood, but not by the arrogant advocacy of science and technology as the only means of increasing our understanding and well-being. They must, instead, advocate the balanced and tolerant presentation of the scientific spirit as one of the great, powerful methods by which man can increase his knowledge and understanding, yet still stand humble and ennobled before the wonder and the majesty of what he does not understand. When thus perceived and carried forward, and when not misused for ignoble ends, science is a major means for "making gentle the life of mankind."

II

The misapprehensions about the nature and purposes of science which have been discussed above may be one of the factors underlying the current shortage of scientists. Every reader of this book must be aware that today the need for scientists and engineers is far greater than the number who are ready to assume these responsibilities. While the United States has experienced shortages of professional talent in the past (notably of physicians), we have not in many years experienced so great or persistent an imbalance between supply and demand as is currently present in science and engineering. The sustained scarcity of professional manpower in these fields, having been widely proclaimed, is now generally recognized, and its handicap to the nation is becoming understood.

Not so well recognized or understood is the qualitative nature of the shortage. We have a shortage of young engineers who are competent to handle new, advanced technologies. We have a shortage of research scientists and engineers, the demand for whom has been doubling every decade. We have an acute shortage of scientists whose creative and conceptualizing powers are exceptional. In summary, our shortage is of basically educated, versatile young talent, rather than of mere numbers.

There is, indeed, a shortage of numbers in many, but not all, fields of science and engineering. We could better cope with such a shortage if we did not also have a severe shortage of quality, depth, adaptability, and up-to-dateness.

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Today our great problem and opportunity is to let science be itself and thus realize its full potential for good. The beneficent applications of science should be given a clear field to reduce the forces tending toward war. The hazard we face is that science will be so identified with destruction, and so hemmed in by security considerations, that its real significance will be lost, its ranks weakened, and its creativity diminished. If American science is to continue to prosper, if it is to continue to attract its proper complement of creative and gifted minds, scientists must combat the notions that science and engineering are incompatible with the disciplines of the great humanities, that they are narrowly materialistic and destructive of human values.

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The quality of American science and engineering depends upon many factors. It depends upon those attitudes in our society which tend to place a high value on accomplishment in these fields, and which affect the motivations and the recognition so vital to achievement in any field. It depends upon whether our society values and rewards creative intelligence. ... upon the success of our society in identify-

In recent years the United States has rounded out a public system of mass education which is magnificent in its accomplishment. We must maintain this system in a state of vigor; we must make sure that we provide the means for it to meet the swelling numbers that result from our rapid growth in population. But we must do more. We must make sure that our public school system maintains the methods, the ideals, and the people who will spot able youngsters and give them special opportunities so that they may make a maximum contribution to our society. All too frequently the youngster of exceptional intellectual ability is the underprivileged youngster in our schools.

One-third of the top two per cent of the graduates of our high schools are not going to college. Some are not motivated; some do not have the means. To augment the quality of our science and other professional work, we must provide the motivation and the means for more of this missing third to get a college education.

The quality of American science and engineering depends also upon strengthening science teaching in the secondary schools. In June, 1955, teachers' colleges and other institutions graduated less than 250 teachers of physics for our secondary schools. Half of these were attracted away from teaching by ... ment. At present rates of education, we

and secondly to the inadequate status and emphasis given science in secondary schools. In remarking this, I hasten to make clear that I do not feel that the teaching of science should

be given such overriding attention and privilege in our public schools that other fields are weakened, and the curriculum distorted, as a result. This is not the way to solve the problem. I do think the evidence is clear that in the secondary schools science teaching has suffered more than teaching in any other field.

While the quantity and quality of scientific manpower are affected by many factors, I feel sure that one of the most important ways to insure a steady flow of first-rate young minds into the scientific field is to widen the public understanding of science.

III

Another condition which calls for better public understanding of science is the impact of science on public policy and the impact of public policy on science. The Federal government now spends over two billion dollars a year on research. As the principal source of all research funds, the government profoundly influences our entire national research effort. The ways whereby the government reaches decisions on how to spend its research funds, and the wisdom it uses in reaching these decisions, have a new order of importance in our national life, and the citizen has a stake in research hardly dreamed of even a quarter century ago.

Clearly, the makers of public policy and the citizens they represent need as never before to increase their understanding of science. If we are to maintain a favorable environment for scientific advancement, and if the nation is to deal wisely with the great technological forces of our time, it is vital that the scientist speak out of his specialized knowledge on the meaning of science to our society.

We have urgent need of more scientists and engineers who can build bridges of understanding between the domain of science and the domain of non-science. We need a growing body of exposition to make science and scientific activity understandable to laymen. Therein lies the importance of books such as this one.

1. The World of Science

LEONARD ENGEL

The World That Science Deals With

The following article was written especially for this book.

Throughout much of western history, philosophers have been concerned with the nature of knowledge and the relation between what we know and the world outside. The question was, is the world real, and thought essentially a reflection of the world within the mind? Or is thought the ultimate reality? Putting it another way, does the world exist apart from what we perceive and therefore know of it, or is what we perceive the end of things? Would the sea be blue in the absence of anyone to see or know blueness?

An answer may be inferred. Thus, I am sure the sea would still be blue if man ceased to exist (and perhaps even a little bluer, owing to the diminution of pollution). But neither this nor the contrary view can be proved by strictly logical means —which may be one reason why the question was debated so long and with so much heat.

This kind of question is seldom asked nowadays. It isn't that man is less curious or less profound than he used to be. The question is no longer asked because science has, in a way, settled it.

Science and scientists act as though the world were real and had an existence quite apart from and beyond what we know and perceive. Scientists are forever sharpening their perceptions

and pushing into the unknown, and finding something there to be perceived. Scientists also take great pains to exclude opinion and their own errors as observers from experimental results; this implies a belief in an "objective" world. So does the important scientific activity of generalizing from observation and formulating natural "laws."

At root, however, the belief in an "objective" world is an unprovable assumption. For scientists are no more able than philosophers to prove that which is not known, and they cannot *know* any better than philosophers what lies beyond that which has already been perceived. But science has been so successful that it rarely occurs to anyone to challenge the assumption the world is real. Through science, people are so busy doing things that they attach little importance to the question of whether objective reality really exists.

The world that science deals with is usually divided into three areas: the area of the natural or physical sciences, the biological sciences, and the social sciences respectively. The physical sciences take in phenomena like heat, light, and gravitation, the laws of mechanics, the basic principles of chemical combination, and (more recently) the structure of the atom. The biological sciences deal with the world of living creatures, from smallest to largest. The social sciences deal primarily with man as a social animal. (For a more detailed classification of the sciences, see the diagram "The Family Tree of Science" and accompanying text on pages 21 to 25.)

Of course, man has been interested in all aspects of the world around him since early times; even the ancients wrote extensively, if not always with the same approach as we, in all three areas of science. But the physical sciences were the first to develop into modern form. The process began in Europe in the thirteenth to fifteenth centuries. Physics emerged into what a modern physicist would readily recognize as physics with Galileo in the seventeenth.

Physics came first partly [illegible]
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tively easy to observe. Animals and plants are more variable and harder [redacted] make observations on. So [redacted] was not until the eighteenth century that systematic methods of classifying plants and animals were worked out, and biology's first great general law—Charles Darwin's law of organic evolution—was published only in 1859. Physiology, the branch of biology that studies how plants and animals work, is a product mainly of the twentieth century.

The social sciences have the most complex subject matter of the three areas of science, and the most recent origin. In fact, they have hardly entered the first stage in the development of any science—the description of phenomena. In most of the social sciences, the formulation of enduring, useful general laws seems still [redacted] be some distance off.

In the course of the past half century particularly, scientific work and scientific workers have both multiplied enormously. The result has been the rapid growth of specialization. Scientific investigators have, too often, been reduced to a species of mole, digging away each in his own tunnel, completely unaware of what is going on in the next tunnel, indeed, hardly aware that there is a next tunnel.

The mushroom growth of specialization has probably been unavoidable. Even in small sectors of science, research workers have accumulated unmanageable bodies of information and special techniques it may take a lifetime to learn. The swift spread of specialization has nevertheless been doubly unfortunate. By raising barriers between related fields, it has cost the world many useful discoveries and greatly delayed others (like the anti-tubercular compound isoniazid, which was prepared by chemists in 1912, but not found effective in tuberculosis until thirty-nine years later). More serious, specialization fragments nature, giving to each scientific specialist and to all together a distorted view of what they study.

For the world that science deals with is a single world, however diverse its different faces appear. There is an intimate connection among the sub-worlds covered by the natural, the biological, and the social sciences. Each has its own laws; but living organisms also obey the laws of chemistry and physics; and man is at once a social phenomenon, a biological organism,

and an exceedingly intricate bundle of physical and chemical events.

If this were not so, modern medicine would have few of the wonder drugs that have revolutionized medical care, for most of these drugs are products of the chemical laboratory; and science generally would be without the wealth of instruments with which observations are made and facts ascertained, for these instruments are mainly the product of physics and utilize physical principles to make their observations, in whatever field these instruments may be used. For example, antibiotics would not be found in the drugstore had chemists not discovered practical means for producing and purifying them; and astrophysics and chemistry alike would be without that superb tool of analysis, the spectroscope, a product of the physicist's study of light.

During the eighteenth century, a school of French savants, the Physiocrats, attempted to apply to the analysis of society the procedures and laws of the physical sciences, especially Newtonian physics. The attempt was naïve and foredoomed to end merely as a curious footnote in man's intellectual history, for society is more complex than classical physics. But the Physiocrats were nearer right than some of their critics, for they at least recognized the existence of a real link between man and nature and they had the useful idea of bringing the insights of one field of science to bear in another.

The connection among the three areas of science is something like the relation between single- and multicelled living organisms. As we go up through the evolutionary scale, we find life more varied but also more complex. Each form of life has properties and *capabilities peculiar to itself*. But each is also made up of individual cells that "work" in much the same way as the single cells from which life originally came. Multicelled organisms integrate individual cells into a whole that functions at once in its own way and in accordance with the properties of its individual cellular constituents.

It is a truism that living [illegible] ... [illegible] ...ology [illegible] ...ndustry. The most rapid [illegible] in science is coming, and will continue to come, from

the "new" sciences like biochemistry and biophysics, which apply the skills and knowledge of several fields of science to common problems and give practical recognition to the fact that the world that science deals with is one.

Notes on diagram "THE FAMILY TREE OF SCIENCE" (see next two pages)

The diagram on the next two pages lists a number of the main branches of science and illustrates the relationships among them. Applied sciences, as distinguished from "pure" sciences, appear in italics. The lines connect closely allied sciences; thus, as the diagram shows, medicine draws not only on the various branches of zoölogy, but on biochemistry, biophysics and microbiology, and medicine both contributes to and draws on psychiatry.

Three features of the diagram require comment. First, mathematics is listed separately and not with other sciences. This is no accident. Although mathematicians like to think of it as "queen of the sciences," mathematics is not a science, but a tool of science. Of course, mathematics has a life of its own; mathematicians study mathematical propositions without reference to their possible usefulness in science or anything else. But the laws of mathematics are laws of thought and not of the world which, in its many aspects, is what science is concerned with. Laws of nature deduced with the aid of mathematics become laws of nature only ...

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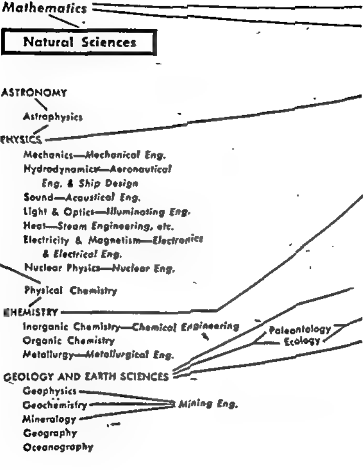
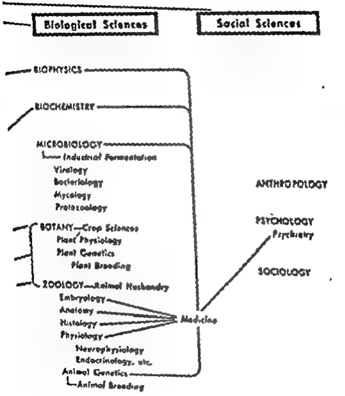
The third comment is that sciences may be classified in either of two ways ... fish, insects, and ... physiology, evol... both in the dia... but where a choice was necessary, the



THE FAMILY TREE


Biological Sciences
Social Sciences
BIOPHYSICS
BIOCHEMISTRY
MICROBIOLOGY
Industrial Fermentation
Virology
Bacteriology
Mycology
Protozoology
BOTANY—Crop Sciences
Plant Physiology
Plant Genetics
Plant Breeding
ZOOLOGY—Animal Husbandry
Embryology
Anatomy
Histology
Physiology
Neurophysiology
Endocrinology, etc.
Animal Genetics
Animal Breeding
Medicine
ANTHROPOLOGY
PSYCHOLOGY
Psychiatry
SOCIOLOGY

OF SCIENCE

second method of classification was used.

Finally, here are brief definitions of the less familiar terms used in the diagram, in their order in the diagram:

Astrophysics—application of laws of physics to study of stars.

Hydrodynamics—study of flow of gases and liquids and movement of bodies through gases and liquids.

Physical Chemistry—application of laws of heat and other physical laws to study of chemical reactions.

Inorganic Chemistry—chemistry, except for chemistry of compounds of carbon.

Organic Chemistry—chemistry of compounds of carbon. So called because it was once believed only living organisms could form carbon compounds.

Geophysics and *geochemistry*—study of physics and chemistry of the earth's crust.

Biophysics—study of physical processes (the optics of the eye, for example) in living organisms.

Biochemistry—the chemistry of life processes.

Microbiology—the study of microörganisms. *Virology* studies viruses; *bacteriology*, bacteria; *mycology*, yeasts and other fungi; *protozoölogy*, amoebae and other one-celled animals (protozoa). *Industrial fermentation* is the use of microbes to produce chemical products, such as antibiotics.

Paleontology—study of fossil remains.

Ecology—study of interrelation of plants, animals, and their geographical environment.

Embryology—study of growth before birth.

Histology—study of structure of tissues.

Physiology—study of how living organisms function. Particularly interesting branches of this important branch of biology include *neurophysiology* (study of the working of the nervous

system) and *endocrinology* (study of hormones).

Genetics—the science that deals with heredity.

Psychology—study of behavior. Its chief application is in *psychiatry*, the treatment of ills of the mind.

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a grave misunderstanding. Indeed it would perpetuate the breach between the world and the experimenter which I have been trying to close. Science is not only rational; it is also empirical. Science is experiment; that is, orderly and reasoned activity. The essence of experiment and of all science is, that it is active. It does not watch the world, it tackles it.

This of course is not peculiar to science. All living is action, and human living is thoughtful action. If this is plain enough as a statement about living, it still needs to be underlined about science: that science is a characteristic activity of human life. The characteristic of human action is that it is a choice at each step between what are conceived to be several alternative courses open to us. Men can visualize these alternatives and animals probably cannot; but in both, action means choice—and this whether we suppose the choice to be free or circumscribed. In both, action is directed toward the future. Men are conscious of this direction, and choose one action rather than another in the conscious hope that it will lead to one rather than another kind of future. I add that this statement describes what they do correctly, whether we think that their choice is free or determined.

This seems to me the most important point which I can make; and oddly enough, it has had least attention in the past. The characteristic of living things is that their actions are directed toward the future. We could put this more bluntly, and say that it is simply the characteristic of action; but this seems to me a needless abstraction, since action and living are in effect interchangeable notions. Living things change; they are different tomorrow from what they were today; and their actions today are directed toward tomorrow. The enzymes in the cell are unaware that what they do will make the cell divide in twenty minutes from now; but if they fail to do it, neither they nor the cell has a future; both die. We do not know what sets in motion the life cycle of the threadworm or the liver-fluke or the oak; but we know that each stage of that cycle is a getting ready for the next; and if the organism misses one cue, it dies. The mechanism of getting ready is odd and elaborate; we see the shadow and close our eyes, we hear a noise and our glands squirt adrenalin into our blood, so that the pulses quicken, the muscles

J. BRONOWSKI

The Common Sense of Science

In the previous selection, we took a look at the world that science deals with and at the family tree of science. Here, science is examined from another point of view by the prominent British physicist J. Bronowski. Science, Dr. Bronowski points out, is a human activity. As such, it has features in common with other human activities. But it also has unique features that have made it an activity apart from other human activities and of especial importance to man.

The article below is condensed from a chapter in a book of the same name by Dr. Bronowski, published in the U.S. by the Harvard University Press. It is used with Dr. Bronowski's permission, and with the permission of the Harvard University Press, Cambridge 38, Mass.

Dr. Bronowski, who is chief physicist of the British Coal Board, is one of the most articulate and eloquent of English writers on science. What makes this remarkable is the fact that English is not his native tongue. Like his fellow-countryman Joseph Conrad, who likewise achieved distinction as a writer and who also came to England at about the same age, Dr. Bronowski was born in Poland and did not come to England until he was twelve years old.

In using the word *observation*, I am *conscious still of having* drawn too passive a picture of the process of science. We may be tempted still to think of the world as going its mighty way and merely impressing on the scientist in *passing* a glimpse from time to time of its imperturbable motion. This would be

and catching the train, to the full use of the most readily won foods of North America.

What marks out science as a system of prediction and adaptation from those of the individual and of the species is at bottom this, that it is a method which is shared by the whole society consciously and at one time. This at once implies that science must be communicable and [illegible] and the predi[illegible] in common. [illegible] horse when t[illegible] a world by sorting out what the [illegible]periences of different people have in common. On the contrary, the practice of science supposes the existence of a real and a common world, and assumes that its impact on each individual who is part of it is modified by him in a way which constitutes his personal experience. We do not construct the world from our experiences; we are aware of the world in our experiences. Science is a language for talking not about experience but about the world.

But what is most striking about the predictions of science is that they are not an assembly of piecemeal guesses. Science is a way of ordering events: its search is for laws on which to base the single predictions. This is the stroke which rounds our picture: that science is systematic in method because it seeks a system of prediction. The aim of science is to order the particular example by articulating it on a skeleton of general law.

Once again, what I have said about science is not peculiar to it. All human conduct is shaped by what the individuals believe to be general laws. The human predictor interprets the signal by an act of recognition which puts it into some general category. We then assume that the future will have some general likeness with futures we have met before which followed this kind of signal, and this is the kind of future we prepare for. We recognize a pair of dumbbells and brace ourselves to lift them; when they turn out to be made of cardboard, the shock is unpleasant because unexpected. What is odd about the generalizations of science is not even that they are far wider, and cover a range of facts beyond the habits of any one individual. This is a real difference, but it is not the essential difference.

tense, and the nerves are alert. But in every case our actions are directed toward some obscurely foreseen future. And this is true of the most primitive cell, and of Gibbon mining mountains of scholarship for the pleasure at last of minting one ringing footnote.

All this is hidden in the process of life; but it becomes plain and explicit when we look for scientific laws. For of course a scientific law is a rule by which we guide our conduct and try to ensure that it shall lead to a known future. The law formulates our anticipation of the future in a systematic way, as a kind of shorthand. And the wider the conditions in which the law applies, and the more compact as it were its shorthand, the more powerful and remarkable we think the law. But a scientific law differs from our own habitual way of pointing our actions toward the future only in being more systematic and explicit . . .

The fundamental ideas which I have been putting forward are these. Every living action is an act of choice. It is directed toward the future. The machine which we conceive within it is a predictor, which interprets past and present information as signals to accommodate itself to an expected future. And interpretation and accommodation cannot be made altogether free from error, for error is essential to the process of learning which directs them.

There is in all this a bold analogy between the way in which individuals learn, the way in which species adapt themselves, and the way in which science works. But, of course, it is my point that this [illegible] *relation. For a* [illegible]

natural selection. But between these extremes there lies the equally human activity of scientific development. The invention and popularization of the breakfast cereal is itself a scientific solution to a complex of problems, which range all the way from cutting down the time between getting out of bed

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The essential difference is that the generalizations of science are explicit. And this derives at once from the fact that science is communicated.

The individual need never make a list of his habits, that is his generalizations, because he does not need to pass them on to anyone else. He will form habits of anticipating the future from present signals even if he never expects to meet another person. Robinson Crusoe did so; and Defoe shows striking psychological insight when he describes the disorder into which Crusoe was thrown when he saw the footprint, not because Crusoe feared the presence of other people, but because their presence had ceased to be part of his conceptual world. Although we cannot be sure, it is likely that some animals lack any form of communication; yet it is certain that they still form habits.

It is the explicit character of its laws which makes science a different activity; and this character derives from communication. Science is the activity of learning by a whole society, even though that society may so divide its labor that it passes the responsibility for this activity to a few men. And the laws of science are those principles of prediction and adaptation to the future which apply to the whole society, and can be learned by all its members in explicit form. . . .

WALTER B. CANNON

Gains from Serendipity

In investigating nature, the scientist often has a pretty good idea of what he is looking for and ultimately discovers. For instance, when Mendeleev devised the periodic table of the elements, there were gaps in the table that obviously belonged to elements then unknown. From the table, it was possible to predict what they were and even, in a general way, what their properties would be. A systematic search was made for them, and they were found. Since science is essentially a voyage into the unknown, however, many discoveries are bound to be more or less unexpected. In "Gains from Serendipity, Dr. Walter B. Cannon discusses the role of unexpected discovery in scientific advance.

"Gains from Serendipity," which appears here in slightly abridged form, is on the way to becoming a scientific classic. It is a chapter in Dr. Cannon's autobiographical memoir, The Way of an Investigator, published by W. W. Norton & Co., Inc., in 1945, the year Dr. Cannon died, and is reprinted with their permission. Dr. Cannon was dean of American physiologists. From his laboratory at the Harvard Medical School came, for forty years, a steady stream of important discoveries concerning the ductless glands, surgical shock, and many other aspects of physiology. He was also widely known as an able and engaging lecturer and writer.

In 1754 Horace Walpole, in a chatty letter to his friend Horace Mann, proposed adding a new word to our vocabulary, "serendipity." The word looks as if it might be of Latin origin. It is

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able to one engaged in a search and the enterprise has proved fruitful.

In the records of scientific investigation this sort of happy use of good fortune has been conspicuous. A good example [redacted] afforded by the origin and development of our acquaintance with electrical phenomena. It is reported that some frogs' legs were hanging by a copper wire from an iron balustrade in the Galvani home in Bologna; they were seen to twitch when they were swung by the wind and happened to touch the iron. Whether the twitching was first noted by Luigi Galvani, the anatomist and physiologist, or by Lucia Galvani, his talented wife, is not clear. Certainly that fortuitous occurrence late in the eighteenth century was not neglected, for it started many researches which have preserved the Galvani name in the terms "galvanize" and "galvanism." And it also led to experiments by his contemporary, Volta, on the production of electric currents by contact of two dissimilar metals—and thus to the invention of the electric battery—experiments so fundamentally important that Volta's name is retained in the daily use of the words "volt" and "voltage."

Such were the accidental beginnings of the telegraph and indirectly of the telephone, radio-broadcasting, and the promise of practical television. And such also were the beginnings of our knowledge of animal electricity. We now use it, for example, to indicate the disordered state of the heart, because every cardiac contraction sends forth through our bodies an electrical wave, a wave that has a different shape according to the damage in the heart muscle. Only recently have we begun to employ animal electricity to give us information about conditions in the brain. That marvelous organ composed of many billions of nerve cells can display rhythmic electrical pulsations and, when extremely delicate instruments are applied to the scalp, they can reveal the different types of pulsations [redacted] rest and activity and the modification in some states of disease. . . .

In the biological sciences serendipity has been quite as consequential [redacted] in the physical sciences. Claude Bernard, for example, had the idea that the impulses which pass along nerve fibers set up chemical changes producing heat. In an experi-

rarely used. *It is not found in the abridged dictionaries.* When I mentioned serendipity to one of my acquaintances and asked him if he could guess the meaning, he suggested that it probably designated a mental state combining serenity and stupidity—an ingenious guess, but erroneous.

Walpole's proposal was based upon his reading of a fairy tale entitled *The Three Princes of Serendip*. Serendip, I may interject, was the ancient name of Ceylon. "As their highnesses traveled," so Walpole wrote, "they were always making *discoveries, by accident or sagacity, of things which they were not in quest of.*" When the word is mentioned in dictionaries, therefore, it is said to designate the happy faculty, or luck, of finding unforeseen evidence of one's ideas or, with surprise, coming upon new objects or relations which were not being sought.

Readers who remember Bible stories will recall that Saul, the son of Kish, was sent forth to find his father's asses, which were lost. In the discouragement of his failures to find them he [illegible] Samuel told him not to set [illegible] hat he [illegible] was announced, and the people shouted their approval. Thus modest Saul, who went out to seek lost asses, was rewarded by a kingdom. That is the earliest record of serendipity I am aware of.

Probably the most astounding instance of accidental discovery in either ancient or modern history was the finding of the western hemisphere by Columbus. He sailed away from Spain firm in the faith that by going west he would learn a shorter route to the East Indies; quite unexpectedly he encountered a whole new world. It is noteworthy that he was not aware of the significance of what he had found. Indeed, it has been said that he did not know where, in fact, he was going nor where he was when he arrived nor where he had been after his return, but nevertheless he had had the most [illegible]

One day an old and forgotten bacterial culture was being used for inoculating fowls. The fowls became ill but did not die. This happening was illuminative. Possibly by first using cultures that had little virulence and then repeating the injections with cultures of greater virulence, the animals could be made to develop resistance to infection gradually. His surmise proved correct. By this procedure, as readers of his dramatic biography will remember, he was able to immunize sheep against anthrax and human beings against rabies.

It was an accidental observation which ultimately resulted in the discovery of insulin and the restoration of effective living to tens of thousands of sufferers from diabetes. In the late eighties of the last century, Von Mering and Minkowski were studying the functions of the pancreas in digestion. While attempting to secure more evidence they removed that organ from a number of dogs. By good luck a laboratory assistant noticed that swarms of flies gathered round the urine of these animals, a fact which he mentioned to the investigators. When the urine was analyzed, it was found to be loaded with sugar. Thus for the first time experimental diabetes was produced, and the earliest glimpse was given into a possible cause of that disease. . . .

An unforeseen contingency may occasion scientific advances because of the serious problem it presents. A striking instance is afforded in the use of polished rice. There was no reason to anticipate that the polishing of rice would be harmful to those who depended upon it as a food. Yet removal of the covering from the kernels produced in myriads of victims the disease beriberi, resulting in immeasurable sorrow and distress. As has been pointed out, however, the study of beriberi, thus unwittingly induced, disclosed not only the cause of that disorder but also started explorations in the whole realm of deficiency diseases and thus led to the discovery of some of the most intimate secrets of cellular processes. . . .

In the life of an investigator whose researches range extensively, advantages from happy chance are almost certain to be encountered. During nearly five decades of scientific experimenting instances of serendipity have several times been my good fortune. Two experiences I mention elsewhere, but

ment performed about the middle of the last century he measured the temperature of a rabbit's ear and then severed a nerve which delivers impulses to that structure, expecting, in accordance with his theory, that the ear deprived of nerve impulses would be cooler than its mate on the other side. To his great surprise it was considerably warmer! Without at first knowing the import of what he had done, he had disconnected the blood vessels of the ear from the nervous influences that normally hold them moderately contracted; thereupon the warm blood from internal organs was flushed through the expanded vessels in a faster flow and the ear temperature rose. Thus by accident appeared the first intimation that the passage of blood into different parts of the body is under the government of nerves—one of the most significant advances in our knowledge of the circulation since Harvey's proof, early in the seventeenth century, that the blood does indeed circulate in the vessels.

Another striking instance of accidental discovery has been described by the French physiologist, Charles Richet, a Nobel laureate. It was concerned with a peculiar sensitiveness toward certain substances—such as white of egg, strawberries, ragweed pollen and numerous others—that we now speak of as *anaphylaxis* or *allergy*. This may result from an initial exposure to the substance which later becomes poisonous to the victim. The phenomenon had been noticed incidentally before Richet's studies, but because it did not receive attention its characteristics were virtually unknown. In his charming little book *Le Savant*, he has told the story of how quite unexpectedly he happened upon the curious fact. He was testing an extract of the tentacles of a sea anemone on laboratory animals in order to learn the toxic dose. When animals which had readily survived that dose were given after a lapse of some time a much smaller dose (as little as one-tenth), he was astounded to find [illegible]

Pasteur was led by chance to his method of immunization.

teria underwent dissolution in the neighborhood of a mold which accidentally contaminated it. This was the pregnant hint. A careless worker might have thrown the culture away because of the contamination. Instead, Fleming let the mold grow in broth and thus learned that there passed into the broth from the mold a substance which was highly efficacious in stopping the growth of a wide range of disease-producing germs and destroying them. Furthermore he learned that, when injected, this substance was not itself harmful to animals. The mold, a variety of *Penicillium*, suggested the name "penicillin." The long struggle of Howard Florey and his associates at Oxford in purifying and standardizing this highly potent agent and in proving its value in human cases cannot be recounted here. [illegible] one of the most striking instances

Long ago Pasteur recognized that when accident favors an investigator it must be met by sharp insight, for he uttered the wise and discerning dictum, "*Dans les champs de l'observation, le hasard ne favorise que les esprits préparés.*" Even before Pasteur, Joseph Henry, the American physicist, enunciated the same truth when he said, "The seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

not in relation to serendipity. One was stoppage of the movements of the stomach and intestines in times of anxiety. The other was the strange faster beating of the heart, after all its governing nerves were severed, if the animal became excited or if sympathetic fibers were stimulated in some remote region of the body. This effect, due to an agent carried to the heart by the circulating blood, led to the discovery of *sympathin.* Both phenomena were quite unexpected. Proof that the stoppage of digestive movements was due to emotion was the beginning of many years of research on the influence of fear and rage on bodily functions. And the unraveling of the mystery of sympathin led ultimately to prolonged studies on the chemical mediator that serves to transmit influences from nerve endings to the organs they control. . . .

Three legends of accidental leads to fresh insight serve to introduce the next point, which is quite as important as serendipity itself. I refer to the presence of a prepared mind. It is said that the idea of specific gravity came to Archimedes as he noted by chance the buoyancy of his body in water. We have all heard the tale, illustrative even if not authentic, that the concept of a universal law of gravitational force occurred to Isaac Newton when he saw an apple fall from a tree while he lay musing on the grass in an orchard. Of similar import is the story that the possibility of the steam engine suddenly occurred to James Watt when he beheld the periodic lifting of the lid of a tea kettle by the steam pressure within it. Many a man floated in water before Archimedes; apples fell from trees as long ago as the Garden of Eden (exact date uncertain!); and the outrush of steam against resistance could have been [illegible] the discovery of fire and its use under [illegible]

discovery involves both the phenomenon to be observed and the appreciative, intelligent observer.

I may now add to these legends and their illustrative significance the history of that marvelously powerful enemy of infection, penicillin. In 1929 the English bacteriologist, Alexander Fleming, reported noticing that a culture of pus-producing bac-

2. The Earth and the Universe

GEORGE GAMOW

The Origin and Evolution of the Universe

Professor George Gamow of George Washington University is not only a theoretical physicist of the first rank, but one of the ablest writers on science in the English language. His many enormously successful books include The Birth and Death of the Sun, Atomic Energy in Cosmic and Human Life *and the several adventures of* Mr. Tompkins *(one of which is quoted from elsewhere in this volume). The interesting point for most of Dr. Gamow's writings plainly show it is that English is not Dr. Gamow's native language. He was born in Russia and came to the United States only in 1934, at the age of thirty.*

The article below is condensed slightly from a lecture given by Dr. Gamow at a number of universities in 1950 and 1951 under the auspices of Sigma Xi, a scientific society that sponsors a distinguished series of lectures each year. Recent advances in astronomy necessitate only one change in the lecture (which is reprinted with the permission of Dr. Gamow, the American Scientist, *and the Society of Sigma Xi). Dr. Gamow gives the age of the universe, as calculated from its size, at 1.8 billion years. In 1952, it was found that the universe is twice as large as was believed. Hence, its age, as calculated from its size, is over twice as great, or roughly 5 billion years—a figure that agrees much better than 1.8 billion years given in the original lecture with other estimates of the universe's age.*

The problem of the origin of the world has been occupying human minds ever since the dawn of history. All ancient re-

[illegible] may be set at a few billion years ago [illegible]

Once the rock is solidified from the originally melted state, this [illegible] lead stays together with the original [illegible] [illegible] we can get [illegible] for the age of a given [illegible]

[illegible]

figure as the lower limit, and possibly as a good actual value for the age of the earth. . . .

Astronomers have essentially three different methods for judging the age of the stellar universe. The first is based on the study of stellar motion within our system of the Milky Way, and refers to the statistical distribution of stellar velocities which is expected to approach a certain "limiting distribution" (the so-called equipartition of energy between all stars) when the stellar system has existed for a sufficiently long time. The observed velocity distribution is still some way off from that "limiting distribution" [illegible]

[illegible]

ican skills, private or public—with all the available money and skills of the other industrialized nations thrown in—are not enough to lift the world from its misery and put it on its feet. There is not that much money, and there is not that much skill. But a comparatively modest investment of money and skills may provide the slap which can set a new-born economy to breathing.

If projects launched as a result of the Bold New Program are chosen on a basis of need and practicality, if they are operated by businessmen under politically stable conditions, the cost can be kept in a sensible ratio to the accomplishments, and the investment can be returned.

Only after the ground has been readied—in some cases by government-financed developments, in all cases by achievement of friendly governmental attitudes and a minimum level of health, agriculture, schooling, communications, and transportation—is private investment likely to assume significant proportions.

The investors will have to submit to conditions laid down by a newly sensitive world conscience—conditions making selfish exploitation difficult or impossible, and frequently eventuating in local control of the enterprises that have been established. The United Nations has insisted that aid must not be "a means of foreign economic and political interference in internal affairs." Wherever possible, local capital should be interested, and always local skills should be developed and utilized in the projects.

Recipient areas will have to learn, too, that the biggest way of doing things is not always the best way. Sound industrialization grows indigenously, and from the ground up.

The countries in which investment takes place will have to relax the onerous conditions which now too often surround the introduction of foreign capital—and agreements to that effect should be spelled out in advance. We face the paradox that while political stability and willingness to abide by the rules of the international free-capital market are long-range goals

far-sighted foreign policy. Yet even now the administration feels obliged to spend in the neighborhood of a billion dollars a year to support farm prices, which implies uneconomic import restrictions—as in the cases of butter, wool, sugar, wheat, cotton —and willingness to dump our surplus abroad. Dumping does not bolster international amity. Instead, as John Davenport observed in *Fortune* magazine, "It makes nonsense of the Administration's whole reciprocal-trade and low-tariff policies, and the lip service that is given to promoting world trade."

It is by no means a foregone conclusion that this country, given a domestic crisis, will turn its back on the rest of the world. But the temptation to cut our foreign commitments will be strong. Indeed, it is on the persuasive power of that temptation that Russia seems to have gambled much of her postwar foreign policy.

Already such opinion makers as Henry Hazlitt, writing in *Newsweek*, are urging us down the path foreseen by the Kremlin. The Bold New Program, which can be one of the most telling blows ever delivered against expanding Communism, is credited by Hazlitt to Earl Browder and the Communist Party. He complains that "Every million dollars of capital we send abroad sets back our own capital development by just that much."

In the event of a real depression there will be others to argue, [illegible]

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with its trouk [illegible]
threats of wa[illegible]

It will be [illegible]
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this venture in good neighborliness a hastily daubed-on war-paint, serving to impress ourselves and others while we do battle with the Russian bear? Once the bear is no longer a threat, how strong will be the impulse to wash our faces and disappear with a sigh of relief into the tent where we have not only lived but lived fatly for so many generations?

[illegible] before, and never could be, but for the harsh external pressure to which they are being subjected." But coalitions based simply on [illegible] minds of men.

On Capitol Hill and elsewhere there still lingers [illegible] co-operation is the continuing growth of the American state structure itself.

As far back as 1920, Franklin K. Lane, then Secretary of the Interior, recognized that "if not only nationals but States themselves, represented by [illegible] *petition, and turn them* [illegible] *turing firms, there is n*[illegible] *will constantly arise fro*[illegible] *rivalry.*

A strongly centralized government cannot help seeking by every means in its power to enhance its own sovereignty Whether the State is protecting its subjects from the incursions of Tunisian pirates, or establishing tariff barriers for the protection of infant industries, or channeling exports into its own ships, or supporting farm prices, or devaluing its currency, it feeds and grows on the services it performs A powerful State is no more eager to subordinate itself to international law than a chinchilla is to become part of a fur coat.

*Nor is the fight between immediate local interests and ulti*mate world interests an easy one to resolve. The U. S of today, for instance, has developed by trial and error an impressive and

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In the event of a real depression there will be others to argue, perhaps more plausibly, for a self-contained and self-centered America. It will be pointed out that we are not a nation at all but a *continent*—nay, a hemisphere. We need not sell our surplus abroad, because we can dispose of it to our own people through TVAs, stamp plans, housing, social security, medical insurance, and a thousand and one vast governmental developments. It will be argued that economically the eastern world, with its troublesome Russia, its starving millions, its wars and threats of war, is not a necessity to us. It is *simply a nuisance*.

It will be contended, with evidence, that if tomorrow the earth were to shudder, twist, and finally wrench apart like a giant amoeba, the eastern half careening off into space and the

this venture in good neighborliness a hastily daubed-on war-paint, serving to impress ourselves and others while we do battle with the Russian bear? Once the bear is no longer a threat, how strong will be the impulse to wash our faces and disappear with a sigh of relief into the tent where we have not only lived but lived fatly for so many generations?

It is doubtless true, as Winston Churchill says, that "under the impact of Communism all of the free nations are being welded together as they never have been before, and never could be, but for the harsh external pressure to which they are being subjected." But coalitions based simply on fear ordinarily break up when the fear is at an end, unless the interim has been used for wise and permanent building; and no small part of that building must take place in the minds of men.

On Capitol Hill and elsewhere there still linger a number of unregenerate and semi-regenerate isolationists. Their influence at a critical moment should not be discounted. But a more insidious danger to international co-operation is the continuing growth of the American state structure itself

As far back as 1920, Franklin K. Lane, then Secretary of the Interior, recognized that "if not only nationals but States themselves, represented by governments, take part in economic competition, and turn themselves into business houses or manufacturing firms, there is no hope of appeasing the conflicts which will constantly arise from commercial rivalry "

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It will be contended, with evidence, that if tomorrow the earth were to shudder, twist, and finally wrench apart like a giant amoeba, the eastern half careening off into space and the

western half continuing to spin undamaged around the sun—if that were to happen, we should have lost no physical thing that we cannot do without.

No man knows when the situation may arise which forces us to demonstrate once for all whether we are a reliable segment of the comity of nations. But the decision which will be revealed then is being made now, in the day-to-day thinking of 150,000,000 Americans. Being human, we are selfish. The chances are that if we were really convinced we could once again survive and prosper by ourselves, taking no part in the troubles of Europe, Africa, and Asia, we would set up our own iron curtain, whatever the cost to the rest of the world. Let us see, then, what the outlook for a self-contained America would be.

The United States is foremost among nations in the production and consumption of agricultural and mineral wealth. We have within our borders, or near at hand, the great majority of the minerals and plants which are necessary for the kind of life to which we have become accustomed.

Indeed, in many fields we have only begun to exploit our domestic resources. The Department of Agriculture *Yearbook* reported in 1938 that by modern methods we could farm without damage twice as much land as was then actually under cultiva-

our food supply another 20 per cent by 1954. That does not sound as if we need the eastern hemisphere.

In the eighty years between 1861 and 1941, Americans cre- [illegible] industrial system the world had [illegible]

system. [illegible]
sphere.

Peru, and Cuba; platinum from Canada and Colombia; tin, without which automobile, airplane, railroad, and ship transportation would cease, from Bolivia; tungsten from Bolivia and Peru. Manganese has recently been discovered in quantity in Brazil, while low-grade deposits exist in most of our western states. Even cobalt and chromite exist, though apparently in inadequate quantities, in the state of Idaho.

Most of the essential agricultural products which will not grow within the borders of the territorial United States are plentiful to the south of us. Bananas, coffee, tea, camphor, tropical oils, sisal, quinine are all products of Latin America. Scientists today are seeking means of synthesizing or finding substitutes for other plant growths, as has already been done for such key imports as rubber. They are also seeking ways of growing these tropical products within the United States proper. Bananas may yet shade your apartment house roof.

How would a self-contained economy be catalyzed? How would we keep living standards and consumer demand spiraling upward along with our productive capacity? The blueprints call for more and more planning and spending, with government, industry, labor, and agriculture working as a team. Some examples:[1]

1. In the United States today there are 7,500,000 dwelling units so run down and so unwholesome that they are below reasonable standards of health and safety. To replace them with homes of minimum decency would cost $50,000,000,000, expended perhaps over a half a century and providing work for hundreds of thousands of men.

2. More than 300,000,000 acres of crop and pasture lands, if they are to be saved, must be protected against further erosion. The job could be done for $4,500,000,000.

3. To retire 11,500,000 acres of submarginal land, resettling 500,000 farm families who now live on them, would take $500,000,000.

4. There are 21,000,000 acres under irrigation in the west.

[1] Figures from *America's Needs and Resources* (New York: Twentieth Century Fund, 1947).

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Indeed, in many fields we have only begun to exploit our domestic resources. The Department of Agriculture *Yearbook* reported in 1938 that by modern methods we could farm without damage twice as much land as was then actually under cultivation. During the war we added 30,000,000 acres to our crop land and increased our food production by a third. It has been estimated that improved crop and livestock practices will increase our food supply another 20 per cent by 1954. That does not sound as if we need the eastern hemisphere.

In the eighty years between 1861 and 1941, Americans created the most tremendous industrial system the world had ever seen. In the next four years they doubled the productivity of that system. That does not sound as if we need the eastern hemisphere.

Of the ores we lack, most are available in our own half of the world. Antimony—for ball bearings, bullets, and batteries—comes from Peru, Mexico, and Bolivia; bauxite, a basic part of aluminum, from British and Dutch Guiana; copper from Chile,

a part of our natural defense sphere. But it is not demonstrable that the United States could prevent a foreign [illegible] event of war [illegible] it [illegible] products. Even the north-ern [illegible] of Canada, where some key mineral reserves (including uranium) are located, are by no means immune from attack.

The only way that the United States could make reasonably sure of holding onto Latin American reserves, in the event of a war in which the western hemisphere stood alone against the East, would be to occupy Latin America now. The coin of isolationism thus has the head of Caesar stamped on the other side.

Left to our own resources, we should be consuming our mineral patrimony at a prodigious rate each day, with no faintest possibility of ever replacing it. In the past fifty years the United States alone has produced—which means we have consumed—more minerals than the whole world had used prior to that time. Those minerals are gone forever. High-grade iron supplies are shrinking. In 1949 the Bureau of Mines estimated that high-grade copper would last thirty-four years, zinc nineteen years, cadmium sixteen years, lead twelve. We have less than a five-year supply of antimony, tungsten, platinum, mercury.

Vast as our resources once were, we could not have reached our present industrial stature without key materials from the East. Chromite, essential for alloy steels used in the oil and chemical industries, comes from Russia, Turkey, or Southern Rhodesia. For cobalt, we are still dependent on the Belgian Congo, Northern Rhodesia, and French Morocco.

Some 67 per cent of our imports today are raw materials needed to keep our industries going. A minute quantity of imported materials not infrequently supports an immense industry. Twelve large food concerns employing 500,000 men and women, for instance, rely each year on a mere $15,000,000 worth of spices from abroad.

Elmer W. Pehrson, Chief Statistician of the Bureau of Mines, asserts that if we consider a generation an average period be-

per cent more food than

selves eat it,

Even befor

half of our cot

come, moreover, far faster than we have shifted in social and economic habits to absorb it. We have planted more acres and built more factories not only because of demand here at home, but because of calls from abroad. Some day we may be able to consume all we can make, but a great growth must take place in American buying power before that day comes.

Some of the largest industries in the United States today are able to produce on a mass basis only because of the margin represented by the export market. Without that margin—even forgetting the need for foreign raw materials—the price of automobiles, radios, refrigerators, and a thousand other products would be too high for most of us to afford. If the South could not export cotton, it could buy less domestic goods. If millions of farmers were not shipping their produce abroad, they could buy fewer harrows and threshing machines.

In 1949 our steel production was up 12 per cent over prewar levels. We were putting out half again as many shoes, twice as much farm machinery and plumbing and heating equipment. As productivity increases, so does the need for exports.

If our exports were to cease, there would be a cataclysmic decline in mass-production industries employing millions of workers. Their unemployment would cut purchasing power, start the deflationary toboggan which is the nightmare of present-day American business. Exports represent the margin between prosperity and depression.

per cent more food than we consume. We must either make ourselves eat it, stop growing it, destroy it, or send it abroad.

Even before the great depression we sold abroad [illegible] half of our cotton [illegible] a third [illegible], 30 per [illegible], 14 per cent of our automobiles. In some instances we export a higher percentage today.

The recent increase in our industrial capacity and our farm production has come, moreover, far faster than [illegible] in social and economic [illegible] acres and built m[illegible] at home, but beca[illegible]. Some day we may be able to consume all we can make, but a great growth must take place in American buying power before that day comes.

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To have exports there must be imports too. We cannot forever give or lend the dollars which will be used to buy American goods. Those dollars must be earned.

Between 1914 and 1949, according to a study by the European Co-operation Administration, our "favorable trade balance"—the excess in dollar value of the goods we sold abroad over the goods we imported—amounted to $101,000,000,000. But in the same period the U. S. Government sent $68,000,000,000 abroad in grants and loans—now largely in default; private individuals sent $10,500,000,000; business invested the same amount; $15,-500,000,000 of foreign dollar assets in this country were liquidated; and the World Bank loaned $1,000,000,000. In other words, American taxpayers and businessmen have unwittingly financed the excess of American exports over imports.

It has been charged that imports threaten our own domestic production, that highly paid American workers cannot compete with cheaper labor abroad.

Actually, on the contrary, our labor is, in general, not only better trained, better housed, and better fed but far more productive than any other in the world. Even before the war our factory workers put out twice as much per man as those, for instance, of Great Britain; our every miner dug four times as much; our utilities and communications workers had twice the efficiency. The fact that for seventy-five years we have sent out more goods than we have taken in, however it may reflect on our good sense, certainly demonstrates our quality as competitors.

It may seem anti-climactic to sum up the dangers of a self-contained economy in terms of the personal inconveniences which would stem from it.

One man's petty inconvenience multiplied by 150,000,000, however, can have national disaster as its product.

Take the unhappy situation of a purely imaginary couple named Peabody, who live in Pittsburgh because Jim is puddler in a steel mill there.

Jim Peabody has a deplorable habit. He likes a smoke before he gets up in the morning. Not many months after the eastern

hemisphere has slipped off through the heavens he reaches

its all-domestic tobacco tastes much like straw. Mr. Peabody can remember cigarettes composed 10 per cent of tobaccos from Greece, Turkey, and Syria, and flavored with materials from 57 countries.

Mrs. Peabody is an attractive woman. To stay that way she has found it advisable to treat her skin with certain unguents which preserve its freshness, and to touch her lips lightly with coloring before she presents herself to the world. Alas, Mrs. Peabody's cold cream jar is empty this morning, and her rouge cakes on her lips; their key elements are on the sundered eastern half of the globe, making the acquaintance of the Milky Way.

Neither Mr. nor Mrs. Peabody is in the best of spirits at the

Europe and Asia have broken away there is no reason to assume that Brazil and Cuba will not follow.

The mill where Mr. Peabody works has shut down—temporarily, he hopes—for lack of alloy metals. High-grade steel uses 40 different raw materials originating in more than 50 different countries.

Peabody wanders into the living room, throws himself into a chair, and snaps on the radio, forgetting that it has broken down for lack of mica crystals, also from India.

Instead of hearing the morning news, he listens to his wife.

body wonders whether he will be among those drafted to skin the pigs.

For weeks now, Mrs. Peabody has been under the doctor's

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Neither Mr. nor Mrs. Peabody is in the best of spirits at the breakfast table. Mrs. Peabody is accustomed to tea at breakfast, but there is no tea nearer than India. Mr. Peabody has his coffee and sugar, but he is oppressed by the dreadful suspicion that if Europe and Asia have broken away there is no reason to assume that Brazil and Cuba will not follow.

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Instead of hearing the morning news, he listens to his wife. She is complaining bitterly, nowhere in town can she find decent gloves or handbags. The needed kidskins came from India, the lambskins from South Africa and Australia. And if Brazil flies off into space as Mr. Peabody dourly forebodes, there will be no pigskin for shoes either. Of course, Washington may establish its own, government-operated pigskin business. Mr. Peabody wonders whether he will be among those drafted to skin the pigs.

For weeks now, Mrs. Peabody has been under the doctor's

care. Her prescription has run out, and she cannot telephone to have it refilled—the Peabodys have no telephone because the company cannot get mica from India to make new sets.

So Mr. Peabody goes out for the medicine. In the yard, he scowls at his house; it is becoming shabby. Paint is unavailable for lack of tung oil from China, shellac from India, mineral pigments from France.

He considers taking the car, but decides to walk instead. Gasoline is expensive these days, being either hauled from South America or manufactured from coal and shale to protect remaining reserves at home. Besides, 31 of the raw materials that went into his car—not counting the steel—originated abroad. Where will a new car come from when his is worn out?

To top off his frustration, Mr. Peabody finds that the druggist no longer has his prescription in stock. Its ingredients are East Indian and Chinese.

Now, the inconveniences besetting the Peabodys are trivial. But the country is composed of a great many Peabodys, and the total of their lacks and hungers will determine the road along which America moves into the future. When Jim Peabody steps onto the sidewalk from the drug store, and finds police piling out of a squad car to make another of their hopeless raids on the booming black market, there is nothing trivial about the fact [illegible] produce a [illegible] he [illegible] nd proud of it, is turning into A37965x22, subject of the State. Nor is there anything trivial about the announcement from the government loudspeaking system which dins into his ears as he starts home—an announcement that Canada has been given twenty-four hours to reconsider her refusal to grant our perfectly justified demand for free access to her uranium deposits.

Put enough personal inconveniences together and you have slavery—and war.

If America were to be alone in the world tomorrow, her most vital industries could survive only by massive government sup-

port, carrying with it the likelihood of ultimate government ownership. Efficiency would drop; costs would rise; private enterprise would wither. The economy could continue to move only by pouring government billions into valley authorities, fed- ... dized aid, increased social security, ... hese ... tinly ... in in ... ly to welcome government enterprises as encouragement toward a better life and a stabilizer in times of trouble than [redacted] the indis- ... of our economy ...

government. It takes tyranny to build a wall around a continent.

The United States was able to be isolationist for a hundred and twenty-five years only because we were part of an orderly world system, with someone else—England—doing most of the policing. Today there is no longer an orderly world system, and there is no nation with the possible exception of the United States which is capable of creating one. We can be isolationist only in a stable world, and there can be no stable world in which we are isolationist. It is a nice dilemma. To have any faintest chance of ever being able to mind our own business again, we must be willing to mind other people's business, and do so wholeheartedly, for a period of decades, generations, or centuries.

That is the short haul of isolationism. In the long haul the ...

any major attempt at economic self-sufficiency on the part of the United States would be an invitation to war. For the conditions

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days, but we may not turn back. For if today it takes a free and prosperous America to save the world, tomorrow only a free and prosperous world can save *America*.

3

Industrialize — or Starve

PERHAPS THE most powerful ally of those Americans who would leave the old world to stew in its own juice is a dead English [illegible]

[illegible]

To a Malthusian, food or money [illegible] ished land only adds to [illegible] the more they will breed [illegible] there will be for each m[illegible] [illegible]

[illegible] increased by almost 2[illegible] the lament, there wil[illegible] early in the twenty-fir[illegible] century—and even now more than 20,000,000 die of hunger each year [illegible]

[illegible] such a context, business investments, government loans or grants, even personal charities compound the evil they seek to lessen. Marshall Plans, international banks, compacts for freer trade—any and every effort at international co-operation loses its excuse for being. Instead, America's obligation is to husband her resources and prepare herself as best she may for the coming [illegible]

that exist today in two-thirds of the world create a climate where war thrives. Russia or no Russia, where there is misery there will be Communists or some equivalent. Without guidance and friendly aid from the United States, half of mankind today might well be pledging allegiance to the hammer and sickle. Our aid and understanding will still be needed for many decades to come.

It would be pleasant to think that by relieving ourselves of foreign commitments we could devote our energies to exploiting, conserving, and enlarging the resources of our own country. But the surest way to reverse past progress would be to turn our backs on the rest of the world. By our own act we should have turned today's allies into tomorrow's enemies. Our entire product over and above the minimum needed to sustain life would be required for engines of war. We should have to live in chain mail.

On an earth that has shrunk under our eyes to the size of a fist, isolationism is not simply inadvisable. It is impossible. If the world cannot unite with us, it will unite against us. If we flinch from intimacy with an eastern hemisphere of different features and faiths and philosophies, we shall be forced sooner or later into the ultimate intimacy—the intimacy of body against body in deathly combat, and germ against germ, and bomb against bomb.

The alternate road is not a simple one. It means working patiently and persistently for freer trade, even where our own manufacturers and workmen and farmers must pay some part of the first cost; co-operating with other nations even when we cannot always co-operate on our own terms; spending sizable sums of

[illegible]

subordinating our own immediate self-interest in order that we may expect others to subordinate theirs.

We may look back wistfully toward the good old isolationist

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PERHAPS THE most powerful ally of those Americans who would leave the old world to stew in its own juice is a dead English clergyman named Malthus. It was Malthus who calculated one hundred and fifty years ago that mankind would always outgrow its food supply, and that pestilence, famine, and war would be required to redress the balance.

To a Malthusian, food or money invested in an undernourished land only adds to its sorrows. The more food men have, the more they will breed, the more they breed, the more mouths there will be for each mouthful, the more mouths there are, the more mouths will remain unfilled. Food equates with starvation.

These fears are buttressed by the fact that humanity has quintupled its numbers since the seventeenth century, that it has doubled them in the past one hundred years, and that it has increased by almost 200,000,000 in a decade. At this rate, runs the lament, there will be 4,500,000,000 people on our planet [illegible] the twenty-first century—and even now more than 20,-
[illegible]

[illegible] hope-
[illegible] ss at best,
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So the extreme Malthusians. At the opposite pole stand those who insist that the productivity of earth is limitless, that man,

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The alternate road is not a simple one. It means working patiently and persistently for freer trade, even where our own manufacturers and workmen and farmers must pay some part of the first cost; co-operating with other nations even when we cannot always co-operate on our own terms; spending sizable sums of money abroad which could very conveniently be spent at home; creating industrial complexes in other lands which not only may but are certain some day to compete with our own products; subordinating our own immediate self-interest in order that we may expect others to subordinate theirs.

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Balanced production and consumption, however, are dreams of the distant future. Accepting today's habit patterns, simply to feed adequately our present world population would require 50 per cent more food than we have.

Do the 7,000,000 square miles now under cultivation have such an increase in them?

Kirtley F. Mather, head of the geology department at Harvard and a leading student of world resources, says yes. Fast as population has grown during the past twenty-five years, he [illegible] and in [illegible] er acre [illegible] ed seed. [illegible] half as much as the best seed now available in the [illegible]. Today American farms average 17.9 bushels of wheat per acre, but one farm has reached a peak of 74.5 bushels. Russia has announced—without confirmation—development of a winter wheat which yields over 120 bushels an acre.

Mather estimates that by applying generally techniques which already have proved their worth, the present output of American farms can be doubled and perhaps quadrupled.

Fertilizers, soil conservation, pest killers, and improved plant strains are among the major tools being currently used to increase crop production in the United States.

The effect of fertilizers was demonstrated by a TVA experiment on 42,000 farms occupying 6,000,000 acres. The farmers added neither machinery nor man power. By stepping up their use of mineral plant foods, they obtained a 30 per cent rise in the production of meat, eggs, and dairy products over the entire area. Where the fertilizer was spread most thickly the crop yield increased 60 per cent.

Since plants can suffer from hidden hunger just as humans can, not only the great basic plant foods but tiny samplings of other less obvious ingredients must be included in fertilizers. Fortunately, most of the 20 different elements needed for proper manuring of the soil are available in virtually limitless quan-

simply by applying the knowledge he already possesses, soon will be more worried about reducing his paunch than he is now about reducing his numbers.

Must population outrun food supply? If so, let America hoard her food and prime her guns.

Will technical ingenuity inevitably produce all the food that mankind can consume? If so, let us dismiss the present hunger of two-thirds of the world as a passing nuisance, and return to our worry about the price of steaks.

Or is the race between population and food supply in underdeveloped areas perhaps not a law of nature at all but rather a symptom of retarded social and economic systems? And if so, is there an effective means of helping those retarded systems to catch up with the rest of the world?

How much more food can our present crop lands produce?

Today the tillers of earth cultivate some 7,000,000 square miles—about 4,000,000,000 acres. They wring from those acres enough food to keep most of us going; but they would need to harvest nearly half again as much, *in present proportions*, if all alive were to eat well.

If the proportions of one crop to another were changed, however, many nutritionists believe that starvation and undernourishment might be relieved even with present production. The amount of food man must eat to be well fed depends on the kind of food it is.

During the war, for instance, the Friends wished to send a shipload of food to Europe. They asked a scientist at the Massachusetts Institute of Technology how the load should be divided among wheat, peanut oil, and other products to get the greatest possible amount of nutrition into the available space. The scientist spent a week-end figuring. He discovered that by proper combination he could increase the food value 50 per cent above that of most shipments of comparable tonnage.

If all the world's crops were similarly balanced, our immediate food deficit might vanish without the addition of a single pound of food to the over-all supply.

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Balanced production and consumption, however, are dreams of the distant future. Accepting today's habit patterns, simply to feed adequately our present world population would require 50 per cent more food than we have.

Do the 7,000,000 square miles now under cultivation have such an increase in them?

Kirtley F. Mather, head of the geology department at Harvard and a leading student of world resources, says yes. Fast as population has grown during the past twenty-five years, he points out, the means of subsistence has grown faster. Land in the United States which grew but 60 bushels of corn per acre in 1900 can grow 100 bushels by using today's improved seed. The best wheat seed fifty years ago produced less than half as much as the best seed now available in the United States. Today American farms average 17.9 bushels of wheat per acre, but one farm has reached a peak of 74.5 bushels. Russia has announced—without confirmation—development of a winter wheat which yields over 120 bushels an acre.

Mather estimates that by applying generally techniques which already have proved their worth, the present output of American farms can be doubled and perhaps quadrupled.

Fertilizers, soil conservation, pest killers, and improved plant strains are among the major tools being currently used to increase crop production in the United States.

The effect of fertilizers was demonstrated by a TVA experiment on 42,000 farms occupying 6,000,000 acres. The farmers added neither machinery nor man power. By stepping up their use of mineral plant foods, they obtained a 30 per cent rise in the production of meat, eggs, and dairy products over the entire area. Where the fertilizer was spread most thickly the crop yield increased 60 per cent.

Since plants can suffer from hidden hunger just as humans can, not only the great basic plant foods but tiny samplings of other less obvious ingredients must be included in fertilizers. Fortunately, most of the 20 different elements needed for proper manuring of the soil are available in virtually limitless quan-

simply by applying the knowledge he already possesses, soon will be more worried about reducing his paunch than he is now about reducing his numbers.

Must population outrun food supply? If so, let America hoard her food and prime her guns.

Will technical ingenuity inevitably produce all the food that mankind can consume? If so, let us dismiss the present hunger of two-thirds of the world as a passing nuisance, and return to our worry about the price of steaks.

Or is the race between population and food supply in underdeveloped areas perhaps not a law of nature at all but rather a symptom of retarded social and economic systems? And if so, is there an effective means of helping those retarded systems to catch up with the rest of the world?

How much more food can our present crop lands produce?

Today the tillers of earth cultivate some 7,000,000 square miles—about 4,000,000,000 acres. They wring from those acres enough food to keep most of us going, but they would need to harvest nearly half again as much, *in present proportions,* if all alive were to eat well.

If the proportions of one crop to another were changed, however, many nutritionists believe that starvation and undernourishment might be relieved even with present production. The amount of food man must eat to be well fed depends on the kind of food it is.

During the war, for instance, the Friends wished to send a shipload of food to Europe. They asked a scientist at the Massachusetts Institute of Technology how the load should be divided among wheat, peanut oil, and other products to get the greatest possible amount of nutrition into the available space. The scientist spent a week end figuring. He discovered that by proper combination he could increase the food value 50 per cent above that of most shipments of comparable tonnage.

If all the world's crops were similarly balanced, our immediate food deficit might vanish without the addition of a single pound of food to the over-all supply.

tities. Nitrogen, for example, can be drawn from the air itself; phosphate rocks, plentiful in most parts of the earth, can be converted to fertilizer by simple pulverization or by treatment with acid; potassium and calcium are among the eight most plentiful elements in the earth's crust.

Earthworms, bacteriological life, even four-legged animals play their part in achieving nature's balance. In ridding earth of its pests, therefore, scientists proceed with caution. The weed killer 2, 4-D, for instance, has increased corn crops 25 per cent in test areas. It has been equally effective in accelerating sugar cane production. Yet 2, 4-D kills any broad-leafed plant, good or bad. Given a chance, it will strike down cotton or sweet potatoes as ruthlessly as weeds. So scientists insist that 2, 4-D be used only according to doctor's orders.

So too with DDT, the insecticide. Insects destroy up to 15 per cent of American crops every year. DDT, scattered over large areas by air, can cut this destruction in half. Used in conjunction with 2, 4-D it brought about an added production in 1949 of hundreds of millions of bushels of grain and corn, hundreds of millions of pounds of beef and milk. But if the experts have their way DDT will henceforth be applied not indiscriminately but under careful scientific guidance to prevent injury to soil or crops.

A greater menace to crops than weeds or pests is erosion, which has destroyed and is destroying empires. Already it has wiped out a fifth of the crop land of the United States.

Every year erosion is erasing $3,000,000,000 worth of irreplaceable American topsoil—the equivalent of 500,000 acres. Russia, Africa, Asia, Australia, and South America are in no better case.

But though mankind has lost many battles against erosion, it may yet win the war. America's huge soil conservation program of the past fifteen years gives a glimpse of what can be accomplished. Hundreds of thousands of farmers have been taught to follow the contours of hills in plowing and to plant trees to hold water on steep slopes. In 1947 alone, conservation

But it is not enough that present crop areas, farmed by methods newly tested, can in theory generously feed the present population of the world. What are the possibilities of enlarging those areas to take care of the additional 500,000,000 who probably will swarm the earth in fifty years?

The earth has 52,000,000 square miles of land. Man cultivates only 7,000,000. Until recently it was generally assumed that not more than 2,000,000 additional square miles would ever be worth plowing. The remainder was either too poor, too subject to erosion, or too far from market.

Among some soil scientists that figure has undergone recent extensive revision. Estimates of the eventually cultivatable area of earth now range as high as 24,500,000 square miles—nearly half the land surface of the planet. For any predictable future, such estimates are undoubtedly excessive. It is true, however, that modern techniques may turn yesterday's fringe land into tomorrow's rich crop maker.

At the present rate, American farmers are "making" more than 1,000,000 acres a year of crop land and pasture land. They have added nearly 40,000,000 acres, says H. H. Wooten in *The Agricultural Situation*, in the past twenty-five years—during the very period when erosion was lessening our potential at a rate of 500,000 acres a year.

Much of the land-making has been done by mechanical equipment. To blast rocks, fell trees, and pull out stumps is no longer the work of months for sweating men and boys. It has become the work of hours, with tractors and bulldozers doing the pushing and panting. In 1930 less than a sixth of the nation's 5,800,000 farms had tractors; today there are tractors on two-thirds of them. In countries like Britain the percentage of mechanization is even higher.

No less important is irrigation, which today is responsible for 150,000,000 acres of the world's crop area; 300,000,000 more acres can be brought to life by similar treatment.[1]

And the amount of land that may be redeemed by irrigation is

[1] The desalting of sea water, already accomplished on a small scale, may make irrigation of arid coastal stretches feasible within the next decade.

infinitesimal when compared with the acreage that may be opened in tropical jungles by weed-killers and insecticides. A Department of Agriculture official asserts that nearly 5,000,000,-000 untouched acres—more than all the present crop land on earth—could be profitably planted to cane, rice, and other tropic crops after chemical control of undergrowth.

In the far north farm scientists have demonstrated that the growth cycle of grains can be speeded to fit into the briefer growing season—a discovery which opens 300,000,000 untouched acres to farming.

Just as it is technically possible, then, to feed all present-day humanity to repletion by turning tested methods loose on existing farm areas, so it is technically possible to take care of any immediately foreseeable increase in population by adding new acreage.

But if the population keeps right on increasing, still other food sources will be needed. Do they too exist?

Technically again—and the word should be underlined—they do, both on the land and in the sea. On the land there are yeasts to supplement [illegible]

[illegible] even been suggested that the carbon dioxide which comes from the smoke of factory chimneys might be purified and piped into vast greenhouses to increase plant productivity.

At sea there are shoal waters that can be planted, and all the surface that can be sieved.

Appetizing and nutritious foods grow unsuspected all around us. Still living Americans can remember, for instance, when a tomato was considered to be deadly poison. Until a few years ago Americans had never heard of soybeans as a food—yet soybeans are ten to fifteen times richer than wheat flour in minerals, five to ten times richer in the principal B vitamins, four times richer in proteins. Multi-purpose meals based on soybeans have been produced by the thousand for as little as a nickel a meal.

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In Mexico, Massachusetts Institute of Technology scientists discovered recently that a native plant, malva—first cousin to the hollyhock—had more food value than any the Institute had ever analyzed. "Civilized" Mexicans had considered it a weed.

Yeast, equaling meat in proteins and exceeding it in vitamins, costs only a fraction as much. A 10-foot yeast vat will brew as much protein in ten days as a thousand acres of cattle pasture can produce in a year. The present sulphite waste from the manufacture of paper can be fermented into virtually limitless yeast protein.

Today the average crop gives but a part of its food potential to man. The nearly 7,000,000,000 bushels of rice harvested each year, for instance, yield only 75 per cent of their food value. That is now being changed. A processing method developed during the war by a young Persian-American named M. Yonan-Malek turns out rice with twice the vitamin value of the usual smooth, shiny kernel, by preserving the nutrition-filled bran which usual milling methods polish away. "Malekizing" is spreading like wildfire around the world. Its general adoption would raise the food content of rice 25 per cent, without the addition of a single new rice paddy.

Have you ever wondered why corn is good to eat but corn stalks are not? Agronomists have. Using processes similar to those which extract dry plasma from whole blood, they have succeeded in drawing the food value not only from the stalks of

[illegible]

only thrived, but professed reluctance to give up their diet at the end of the experimental period. Dr. Robert S. Harris, director of the Nutritional Biochemistry Laboratories of the Massachusetts Institute of Technology, reports that mixtures developed from fodder can give complete, if unappetizing, nutrition for *$15 a person a year.*

In practice, of course, food essence of any sort is likely to be used not as a complete meal but as a filler to give added nutritive

value to other foods. For full usefulness, food must be varied and appetizing as well as nutritious.

The General Electric research chemist Eugene G. Rochow be-

that of today—simply by growing more trees and converting the

hibitive for most staples. It is to be hoped that such a recourse will never be forced upon us. But it can be done.

Any form of soil farming, say some agronomists, is both in-

increase in organic matter about 15 per cent a day at the utmost until it reaches its maximum growth, some algae can grow over 350 per cent daily—and never stop.

square miles, almost three times the whole land area of earth.

and Japanese.

When the Norwegian anthropologist Thor Heyerdahl drifted from Peru to French Oceania on a raft in 1947, he took with him

value to other foods. For full usefulness, food must be varied

that of today—simply by growing more trees and converting the wood to sugar for human consumption.

Twenty years ago any farmer would have laughed if he had been told he might some day grow crops without any soil at all. Yet pilot factories have demonstrated that in case of need we could build skyscraper farms where plants would grow in shallow tanks of nutrient solution. The cost of course would be prohibitive for most staples. It is to be hoped that such a recourse will never be forced upon us. But it can be done.

Any form of

efficient and pr

ing in growth

sor of biological sciences at Loyola University, Chicago, to the simpler algae, which will grow forever if part of the crop is regularly removed to prevent overcrowding.[2] A wheat plant will increase in organic matter about 15 per cent a day at the utmost until it reaches its maximum growth; some algae can grow over 350 per cent daily—and never stop

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For centuries the Tunisians have harvested seaweed as fodder for their camels. It is part of the normal diet of many Chinese and Japanese.

When the Norwegian anthropologist Thor Heyerdahl drifted from Peru to French Oceania on a raft in 1947, he took with him

will tend to decline. As educational and living standards rise, as contraceptive knowledge spreads, birth rates drop.

The more comfortably man lives and the more hope he has for improving the lot of his children, the more slowly he breeds. In the fifty years between 1876 and 1936 the birth rate of western Europe and the United States fell by more than half.

But birth rates did not drop simply because there was more food. If more food and better health measures had been the only changes introduced into the lives of the West by the Industrial Revolution, there is every reason to believe that the birth rate would have risen instead of fallen.

The big change that took place with industrialization and urbanization was that a large family became, by and large, an economic liability instead of an economic asset. A hundred and fifty years ago, when nine-tenths of all working Americans were farmers, it took the work of four families to provide food for five. Under such circumstances, every child was economically valuable. He could hoe corn, herd and milk cows, weed beets. Today, however, less than 20 per cent of the American population is required to grow all the food that the rest of us need for a comfortable living—plus a vast surplus for shipment abroad. Even on the farms, there is little value in a large family when one tractor can do the work of a dozen men. And in all the other fields opened up by industrialization—in trades, services, factories—the child represents a net economic loss. Even if his parents wanted a six-year-old to start work, the law would say no. He must be fed, clothed, housed, and educated for at least sixteen and often twenty years. The result is shrinking families. The number of children in an American family will tend to rise when it is economically convenient to have more children—and not before.[3]

In an industrializing society there is a lag between the time when births begin to lessen and the time when the population

[3] It is easy to misinterpret the meaning of changing birth rates. During World War II, for instance, GI's married young, became fathers quickly. Yet it would be fallacious to conclude that they were starting a *trend toward larger* American families. So far it appears rather that they simply had their children earlier than they might have done if there had been no war.

stops increasing. The principal reason is that the same conditions which make for fewer births make also for longer life. The woman who marries at twenty-five may have fewer children than her sister who married at twelve, but *probably* she will live [illegible] children as likely to outlive [illegible]

[illegible]

rose by 60 per cent.

But as the births continue to decrease, the growth in popula- [illegible]

[illegible] reaches of this zone. Barring some sensational increase of the present life span, Europe and the United States will stop growing in numbers before the end of this century.

Simply supplying more food to more people, then, would be [illegible]

[illegible] truth is seen by Dr. Burch when he speaks of "how fast the population of the *industrially backward* [italics mine] areas can develop." Without industrialization, nobody has time to become educated. Without industrialization, health and sanitation measures simply mean more people living more miserably.

With a properly balanced industrialization, on the other hand, there are no hopeless areas.

India will serve as a case in point.

India is subject to recurrent famines, in which millions may [illegible]

interests few. Every man is encouraged—in the words of Dr. S Chandrasekhar of the University of Pennsylvania—"to look to his wife and sex intimacy as the only relaxation and recreation in an otherwise dull and unexciting struggle to make both ends meet."

It is true that from 1870 to 1930 Europe grew twice as fast, and the United States four times as fast, as India. That, however, was only because a smaller percentage of Europeans and Americans died.

But even in India, according to Kirtley Mather, the birth rate has been steadily dropping since the turn of the century—dropping as the first wavelets of industrialization have begun to lap the Indians' feet. Between 1920 and 1940 the production of pig iron in India went up more than six times, that of finished steel nearly five times. Promotion of capital and consumer goods industries is a primary plank in the platform of the Nehru government. With the inevitability of an ocean tide, industrialization is coming to the submerged millions of India. Whether it will be so balanced as to bring about a steady rise in living standards remains to be seen; but it is certain that with it will come modernization and eventually a further slackening of births.

Religious beliefs may slow the decline in Indian births; but they are no more likely to stop it there than they were in Catholic Italy, where between 1870 and 1940 the rate decreased by nearly 40 per cent, or in the United States, where on the same economic and social levels there is no significant difference in the number of children born to Catholics and Protestants.

Demographers have estimated that the decline in Indian births will match the decline in deaths by the middle of the next century, and that the population will then stabilize at around 700,000,000 souls.

But such a stabilization, given continued enlargement of food sources, must assume the speeding of industrialization in India. And as with India, so with Japan, whose birth rate, according to Mather, has been turning tentatively downward for twenty-five years.

Dr. Radhakamal Mukerjee, one of India's leading students of

faster on the treadmill, unless they are followed by a self-sustaining process of healthy industrialization. Industrialization is the far-off goal; Point 4 is the essential first step.

4

From Empire to Point 4

BENJAMIN FRANKLIN once sent a young friend ten louis d'or and the following note. "I do not pretend to give such a sum; I only lend it to you. When you shall return to your country, you cannot fail of getting into some business that will in time enable you to pay all your debts In that case, when you meet with another honest man in similar distress, you must pay me by *lending this sum to him, enjoining him to discharge* the debt by a like operation when he shall be able and shall meet with such another opportunity. I hope it may thus go through many hands before it meets with a knave that will stop its progress."

As America prepares to undertake her Bold New Program, we might well ponder Franklin's adjuration. Too frequently we assume that we are a self-made power, owing no debt of gratitude to any other nation. The facts are to the contrary. Almost before the Liberty Bell had stopped pealing, foreign investors were force-feeding the American economy. Even the purchase of the Louisiana Territory was financed in Holland.

The deep depression which overtook the Old World toward the middle of the nineteenth century impelled an immense development of overseas areas, and particularly of the United States. Part of the contribution *took the form of immigration*, with all its attendant skills. Part took the form of capital. The result for Europe was a new swing upward in production and consumption. The result for the United States was to put her development half a hundred years ahead of schedule. When there was little more to be done for us, toward 1875, Europe underwent a new crisis, from which she recovered only by transferring her *initiative to such new outlets* as Australia, South Africa, and Argentina.

fled to London from abroad during the turmoil of twelve European revolutions.

To avoid a disastrous slump, the British money market set about reconstructing Europe; it haphazardly developed the markets of the New World; and when the stimulus of those efforts began to wear off, it opened up the sub-continent of India.

The British isolationists objected as vigorously in 1815 as the Henry Hazlitts in 1950. Was it to be endured, demanded Lord Lauderdale, that the law would interfere to prevent a poor worker from leaving the country, but would permit—nay, encourage—export of "the money of the country, the main nerve of all our resources?" A morning paper reminded the British that "the prosperity of our own, and not foreign people or slaves, constitutes the wealth and prosperity of the British Isles."

But that was whistling into the wind. When continental countries levied high tariffs on British goods, British industrialists countered by exporting the machines to make the goods. When Parliament forbade such exports, saying knowledge of technical improvements should be kept at home, the businessmen simply [illegible]

son John, though lacking British pounds, used British skill and initiative to create mills, factories, mines, and forges for clothing, cotton, machines, paper, zinc. Everywhere the British stirred local capital to activity. Within twenty years after the Treaty of 1815 they had spread the Industrial Revolution across Western Europe.

In Latin America during the early 1820's British enterprises sprang up from Mexico almost to Cape Horn. In Colombia, for instance, one Englishman had exclusive rights for rolling copper, another for salt, a third for the exploitation of all Bolívar's private estates. Two had pearl-fishing concessions. Newspapers were established at Bogotá and Caracas to push British interests. The British even drew up plans for a Nicaraguan canal.

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ish investors turned their eyes toward the United States. We were then a country of little free capital; the produce of a man's farm, to the extent that it exceeded the needs of his own family, usually went toward clearing more land and raising more crops. There was no loose money available for building highways, canals, harbors, and railroads. But to fulfill what we considered to be our destiny such works were essential; and in London, American promoters found a seemingly bottomless pot of gold. Between 1815 and 1830 the British had invested scarcely £5,000,000 in the United States. Within the next ten years the figure approached £40,000,000.

Part of the stimulus was provided by the phenomenal success of the Erie Canal, which was completed in 1825. Dug for 363 miles between Buffalo and Albany at a cost of only $7,143,789, the Canal was financed by issuing New York State bonds, almost all of which were soon owned by Englishmen. Against all historic precedent, the big ditch actually paid its way. In the first year of operations it made enough to meet the interest on its debts. Within ten years it had paid off the principal—and western New York and northern Ohio had been opened up to permanent settlement.

It is difficult to say whether this phenomenon was more bemusing to the Americans or to the British. Every American state promptly decided that it could do as well as New York. By 1836 over $90,000,000 had been spent in the North on railways and canals alone. Most of it was British money, invested in state securities. Two years later total British capital invested in the United States reached twice that figure. In the spring of 1836 Samuel Jaudon of the United States Bank carried on a single trip to England $20,000,000 in securities, together with bonds for a gold loan of £2,000,000. Needless to say, few of the enterprises thus financed were as productive as the Erie Canal.

English pounds stimulated industrial development in the United States perhaps no less than public works, though by more indirect means. The merchant bankers of London preferred to export British goods, not to encourage competition. But once a credit was granted, there was no practical ways of limiting the

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purposes it might serve. By 1839 the *New York Express* could declare that "millions of foreign capital are invested in manufactures in this country."

While the investments succeeded in bringing about a commercial revolution in America fifty years ahead of time, many of the investments themselves were bad business. America was being developed and the merchant bankers made money, but as in the earlier case of Latin America, the British widows and orphans who bought the stocks frequently lost their savings. Like their South American predecessors, the American states found credit too easy and borrowed too much. When hard times came they were unable to pay. After the panic of 1839 nine sovereign states calmly repudiated obligations totaling $100,000,000. The United States Senate expressly disavowed any federal responsibility for state debts. As a result, American credit abroad plummeted [illegible] from heaven to hell. When President Tyler's agent Duff Green went to Paris for more money, Rothschild coldly informed him: "You may tell your government that you have seen the man who is at the head of the finances of Europe, and that he has told you that they cannot borrow a dollar, not a dollar."

Rothschild's comment closed the first, tumbling phase of American relations with the foreign capital market. Our public credit was not completely restored until after the First World War.

[illegible] British looked elsewhere for a place to put [illegible] of £[illegible],000,000. In the [illegible]'s they found [illegible] development of railways. In the 1850's they [illegible] railroad building abroad—to Europe, to Canada, [illegible] Latin America and the United States. [illegible] British capital seeking an outlet, the [illegible] States could not long remain in coventry. [illegible] of the War Between the States British [illegible] had resumed on a large scale, primarily for [illegible] railways. The country already had plenty of contrac[illegible] expertise; all the British had to supply was the [illegible]. By 1869 they had $1,500,000,000 in-

vested here. Since the American East Coast was developing its own capital market, the thoughts of British speculators turned more and more to the comparatively untouched West. English settlements sprang up in Kansas and Colorado. London was instrumental in the financing of the spectacular mining developments that followed the Pike's Peak gold rush. And the years from 1870 to 1900 provided one of the most colorful phases of British investment in this country—the stimulation of our cattle empire.

As early as the 1840's, the Hudson's Bay Company had been busy raising mixed Shorthorn and Durham cattle along the Columbia River. Thousands were loaned or sold to Oregon settlers. For twenty years after 1840, cattle, horses, sheep, and hogs moved from Britain to America in steadily increasing numbers. By the time disease decimated British herds in the 1860's, American cattle were available in quantities sufficient to satisfy even John Bull's appetite for beef.

The herds on the American plains assumed a morbid fascination for the British. The average Briton knew more about the legendary country of cattle and cowboys than did the average New Yorker. One British wag commented: "Every time a cow moves her tail to switch a fly she exerts a force of three pounds. In the course of the summer a single cow wastes 5,000,000 pounds of energy. The cows of America throw away enough power to move every piece of machinery in the world. This is exclusive of kicking milkmaids off stools."

In 1876 the American West sent Britain $2,000,000 worth of refrigerated meat. Live cattle, too, had begun returning to England in enormous quantities. In 1879 an entire fleet of ships was acquired to transport 75,391 head. In the same year the fresh meat trade grossed $6,000,000. This was the era of the influx of young Britishers to the West, where they promptly became the heroes of jocose tales and ballads. Typical was the following report from the *Pall Mall Gazette* of March 15, 1881:

> . . . The Earl of Aylesford lives on his ranche of 37,000 acres in Texas [with] 20 or 30 horses, 13 dogs, and five servants. He has not

tury require a fuller analysis than is possible here. Some points, however, can be conveniently summarized:

1. Investment of capital and skills in areas which were ready to receive them—viz., western Europe—was successful both from the point of view of the investor and of the investee.

2. Investment in countries which were neither economically, politically, nor psychologically prepared to handle such investments—viz., Latin America of the 1820's—lost the money of the investor and did actual harm to the host countries.

3. Investment in countries which could put the money to good use, but which were not yet financially stable or experienced—viz., the United States of the 1830's—greatly accelerated their economic development, but frequently cost the investors their money.

The twentieth century is not doomed to repeat all the mistakes of the nineteenth. But since many of the most essential developments under the Bold New Program lie precisely in those areas where effort is most likely to go to waste and returns are least certain to be forthcoming, we must proceed with prayerful care. We shall do well to remember that we are in a position to proceed at all only because the people of other countries once invested capital, skill, and confidence in a strange, uncouth nation on the other side of the world which called itself the United States of America. Now that it is our turn to pass on what we have received, let us profit by their experience.

In the nineteenth century Great Britain was a mature creditor nation. The United States emerged on the world scene in that century not as a creditor but as a debtor. With minor exceptions she was sending abroad not money but goods.

Under the circumstances it was only natural that the early manifestations of imperialism in the United States were comparatively crude.

In the first days of America's emergence as a great power, it appeared that the only lesson we had learned from Old World imperialism was to play the game ourselves harder and for higher stakes. The speed and thoroughness with which we estab-

Europe, our greatest competitor for world markets. Finally, and perhaps most significantly of all, we have promulgated the Bold New Program, bypassing both imperialism and colonialism in the development of backward areas.

What is the meaning of this deviation from forecast? Have we simply developed a more highly involved, more disarming, and so more horrendous form of imperialism? Or has imperialism proved inappropriate to the provincial American temperament? Or have we reached a position of power so outstanding that the old rules no longer apply, and that our self-interest and the world interest have actually and demonstrably intermingled?

It is certain that even in the heyday of Manifest Destiny we felt uncomfortable about the whole thing. We tried wherever possible to give our little annexations the appearance of popular uprisings; when we took over alien populations we explained with a straight face that we were simply grooming them for independence; when we sent Marines into unsettled areas we were loud in regretting the necessity. But this piety in aggression had been a convention since history began. Nobody, probably not even we, had any notion that we meant it.

Indeed, our history indicated the contrary. By sheer drive we had expanded across a continent in less than a hundred years. We had not hesitated to sweep aside Indians, Old World empires, or the New World neighbor on our southern border. We had formulated the Monroe Doctrine not simply to prevent further European expansion into the Americas but to lay the groundwork for our own expansion southward.

In the last quarter of the nineteenth century we began estab- [illegible] 'ounger in [illegible] This was [illegible] dered tri- [illegible]
giving us the right to establish a naval station in the harbor of Pago Pago; but when the American consul proclaimed a formal

American protectorate over the islands we hastily repudiated him.

In this same absent-minded manner we slipped a hand into the cracker barrel and were astonished when it emerged holding the territory of Hawaii. By 1887 Hawaii was furnishing us

end. This was a surprise to the Queen, who still sat undisturbed in her palace, peaceably governing her islands; but the Com-

had been recognized by the United States minister. Scarcely a month later a treaty of annexation was reported to the Senate.

Here again, however, there entered into play the curious American reluctance to accept the consequences of Manifest Destiny. The American people did not want to become emperors. The treaty became a bone of contention between expansionists and non-expansionists. For five years it failed of passage, and Hawaii was finally annexed by joint resolution only when patriotism had been blown to fever heat by the war with Spain.

With the Spanish-American War of 1898 our expansionism went into high gear. We were caught up by the elation of discovering ourselves suddenly a world power.

By January 1, 1899, the government of Cuba was in the hands of the Americans. They proceeded to give her freedom—with strings attached. The new-born republic was forced to make part of its constitution an agreement never to enter into any treaty which might impair the independence of the island and never

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In the last quarter of the nineteenth century we began establishing an empire in the absent-minded manner of a lounger in a country store sampling crackers from an open barrel. This was the era of what John Franklin Carter calls "unconsidered trifles." We bought Alaska from the Russians to do them a favor, [illegible] of the move from the American public did not die [illegible] treaty with

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to contract any public debt in excess of its ordinary revenues. The United States was given the right to intervene to protect Cuban independence, and was granted coaling and naval stations. Under these provisions, which in the United States were known as the Platt Amendment, we intervened four times in the internal affairs of Cuba. As one historian remarked, Cuba was "no more independent than Long Island."

To the extent that immediate American self interest was at stake in the Caribbean, it is understandable if not justifiable that we should have given Cuba only half her freedom. It was equally understandable that we should have taken over Puerto Rico.

In addition, however, the Treaty of Paris (December 10, 1898) provided for the cession of the far-distant Philippines to the United States in return for a payment to Spain of $20,000,000. Here influences of a balder sort were at work. Whitelaw Reid, one of the Paris Peace commissioners, justified the acquisition as follows:

> The Pacific Ocean is in our hands now. Practically we own more than half the coast on this side, dominate the rest, and have midway stations in the Sandwich and Aleutian Islands. To extend now the authority of the United States over the great Philippine Archipelago is to fence in the China Sea and secure an almost equally commanding position on the other side of the Pacific—doubling our control of it and of the fabulous trade the Twentieth Century will see it bear. . . . The trade in the Philippines will be but a drop in the bucket compared to that of China, for which they give us an unapproachable foothold.

This was raw imperialism and it was a heady wine. It was also deeply disquieting to millions of Americans.

But it was in Latin America, and particularly in the Caribbean area, that we were able to throw our weight around at will. Here are some outstanding instances:

1. Panama. In 1903 Congress authorized President Roosevelt to negotiate with Colombia for a canal across the Isthmus of Panama. The Colombian Senate, however, failed to accept the proposed treaty. By strange coincidence, Panama at once

launched its fiftieth revolution in fifty years, and the United States Navy prevented the Colombian government from suppressing it. Ten days later the new State of Panama ceded the Canal Zone to the United States.

2. Santo Domingo. In 1903, through "gross mismanagement" of her finances, Santo Domingo found herself with a revenue of $500,000 from which to pay the interest of $1,700,000 which was due on her external debt. The United States Government assumed the fiscal administration of the Republic soon afterward. Political intervention followed; and after a series of insurrections United States Marines were landed in Santo Domingo on May 4, 1916. For the next eight years Santo Domingo was ruled by a United States military dictatorship.

3. Haiti. When a revolution in 1915 threatened to bring on French intervention, the United States landed Marines, and forced on the Haitians a treaty giving Haiti an American military high commissioner, a general receiver of customs, a financial adviser, and an American-directed constabulary.

4. Nicaragua. In 1909 Nicaragua opposed United States overtures for a naval base in the Gulf of Fonseca and a second [illegible]

at Bluefields of La Luz y Los Angeles Mining Company, an American corporation. Diaz was receiving a salary of $1,000 a year. Though he was not known to have had other resources, he was able to advance the revolution $600,000, which he eventually repaid himself.[4] American Marines again prevented government forces from suppressing the rebellion. Soon afterward the new regime gave the United States its desired Fonseca naval base, the right to build a canal, and control for ninety-nine years over the approach to it.

The United States intervened in Nicaragua six times to prevent "political anarchy" near the Panama Canal. For similar

[4] *Dollar Diplomacy, A Study in American Imperialism* (London, Allen & Unwin, 1926).

reasons we intervened six times in the Honduras, once in Costa Rica, once in Colombia, twice in Venezuela.

But our stake in Latin America, however dramatic its manifestations, was only part of our growing interest in the outside world. In 1914 the United States still owed other countries $3,686,000,000 on balance. By 1919 we were creditors to the extent of $12,652,000,000. By 1929 that figure had risen to $19,763,000,000. We were, by and large, optimistic investors. During the 1920's, as the British had done a hundred years before, we plunked down our money first and asked what the game was afterward.

Throughout this period, an increasingly important function of the State Department was to assist American investors, many of whom had a prodigious capacity to burn their fingers. Presumably this basic preoccupation of the government not only *has not* changed, but could not change. Yet suddenly, at the very peak of our power and drive, classic dollar diplomacy took sick. By 1933 it was dead. What was it that had happened?

As a creditor nation, it was to our interest to see to it that the countries where we had put our money remained stable, prosperous, and friendly so that they could and would pay the money back. To assure profits by fair treatment was cheaper than to assure them by the use of Marines. It was also more efficient.

Enlightened self-interest coincided with the pricking of conscience. For almost the first time in history, an expanding nation was able to stand back, see itself with some degree of objectivity, and decide that it was busy doing itself harm instead of good. The policy of the big stick was outdated. It no longer worked. Nationalism was on the rise. The thinking of men had moved on; our consciences could no longer tolerate Manifest Destiny.

"The position in which the United States found itself in Latin America," reports one student of the period, "was similar to the position of Great Britain in Persia, in China, in Ireland, South Africa, and India. Our first, fumbling efforts toward a new Latin American policy were little more than an openly ex-

pressed desire to be conciliatory instead of tough, to be a friend instead of a disciplinarian, to co-operate instead of exploiting."[5]

President Coolidge made one of the first gestures toward co-operation in 1927 when he sent Henry L. Stimson to Nicaragua to persuade the rival political factions there to hold an election under United States supervision. The experiment was partially successful, and both parties asked the United States to supervise the election four years later But "That sturdy patriot, General Sandino, refused to accept the compromise with nationalism, and he made the Marines look silly before they gave up chasing him and withdrew in 1933."[6]

In Mexico, too, Mr. Coolidge tried a new tack. A dispute was at full fire over Mexico's seizure of American oil holdings, and United States newspapers were hinting at armed intervention. Mr. Coolidge appointed Dwight Morrow Ambassador to Mexico. When President Calles asked Morrow if he could suggest any solution of the controversy, the Ambassador referred him [illegible] a ruling of the Mexican Supreme Court under the Carranza Administration upholding an oil company's claim to rights acquired before 1917. By acknowledging this precedent, the Mexican government was able to maintain its principle that subsoil was the property of the nation, while the United States maintained its principle that rights acquired before 1917 could not be legislated away When the issue arose again in 1938, the State Department "refused with firmness to sacrifice the friendship of Mexico by any threat of intervention . . . The United States had made good its determination never again to intervene below the Rio Grande."[7]

[illegible]s achievement was historic, remarks his biographer, [illegible] was . . . the first responsible [illegible] inter-vention, [illegible] trine and as such in conflict [illegible]d States. . . . he was the first unwaveringly to support [illegible]

[5] Charles Wertenbaker, *A New Doctrine for the Americas* (New York: The Viking Press, 1941)
[6] Ibid
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Meanwhile, in the 1920's a young diplomat named Sumner Welles had entered a vigorous intellectual dissent to the policy of dollar diplomacy. He wrote:

> The benefits resulting from the military occupation of the Dominican Republic, so far as the national interests of the United States are concerned, have been of infinitesimal importance when compared to the suspicions, fears, and hatred to which the occupation gave rise throughout the American continent. . . . So it has been with every military occupation or intervention . . .
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> It is in the stimulation of commercial ties, in the facilitation of educational advantages . . . in the initiation of financing to productive purposes, in the proffer of technical and expert assistance when it may be needed, that the United States will obtain the results desired, and not through military occupation, military intervention, or armed supervision of elections.

The program advanced by Mr. Welles meant raising imperialism to a level where imperialism ceased to be a meaningful word. He had an opportunity to turn his program into action in 1933, when the incoming President, Franklin D. Roosevelt, named him Assistant Secretary [illegible]

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It was at the seventh Pan-American Conference at Montevideo in 1933 that the United States finally took the step which was to change Latin America from a continent of sullen enemies to one of friends. At that convention the United States reversed its policy of more than a hundred years when Cordell Hull supported a declaration that "no state has the right to intervene in the internal or external affairs of another." Roosevelt backed him soon afterward by asserting that "The definite policy of the United States from now on is one opposed to armed interven-

reliable allies to the south of us in the Second World War. In terms of history, it meant an awareness that imperialism and dollar diplomacy by the United States were dead, and that henceforth our own welfare would be best served by acting as good citizens of the world. The Good Neighbor policy of Franklin D. Roosevelt, Cordell Hull, and Sumner Welles contained the seeds that are springing today in Point 4—the Bold New Program.

5

The Good Neighbor Policy: Bellwether of Point 4

A SOWER, said Jesus, went forth to sow, "and when he sowed, some seeds fell by the wayside, and the fowls came and devoured them up, some fell upon stony places, where they had not much earth; and forthwith they sprung up, because they had no deepness of earth; and when the sun was up, they were scorched; and because they had no root, they withered away.

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In his inaugural speech the new President made a passing statement on which history was soon to hang its hat. "In the field of world policy," he said, "I would dedicate this nation to the policy of the good neighbor—the neighbor who resolutely respects himself, and, because he does so, respects the rights of others—the neighbor who respects his obligations and respects [illegible]

[illegible]

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good neighbor. . . . In this spirit the people of every republic on our continent are coming to a deep understanding of the fact that the Monroe Doctrine . . . was and is directed at the maintenance of independence by the peoples of the continent."

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And some fell among thorns; and the thorns sprung up, and choked them; but others fell into good ground, and brought forth fruit, some an hundredfold, some sixtyfold, some thirtyfold."

In the Good Neighbor policy the United States has sown much as did the farmer in Jesus' parable. We too have cast our seed alike in barren ground, thorny ground, and good soil. The successes and failures of our sowing, whether it took place as government loans, private investments, or technical aid, are graven deeply ... men who are putting together the Bold New ... failures and ... economic field provide a convenient measurement for the likely usefulness of the newer, vaster concept. If, for instance, the Good Neighbor policy is to be turned off and on at our convenience, like a faucet, it will be difficult for underdeveloped areas to place much faith in the long-range reliability of Point 4. It is instructive, therefore, to see how our policy in Latin ... during the past fifteen years.

... al rather than ... feelings. But since people's feelings are intimately connected with their pocketbooks, it was not altogether coincidence that United States investments in Latin America increased until by 1940 they touched the staggering total of $4,000,000,000, of which nearly half represented private investments in business enterprises, securities, and real property. Even before World War II, the Argentine government had received $60,000,000 from the Ex- ... trial and agricultural ... for construction of ... expected to spread industrialization across South America.

Sumner Welles has explained that these loans were "premised on the conviction that social progress and political stability in the hemisphere were contingent upon higher living standards, and that the growth of true democracy was also contingent upon better nutrition, sanitation, education, and communications. It

was believed that the measures of financial and economic co-operation that were undertaken would not only increase the probability of political and military security but also provide a greater demand and increased purchasing power for United States exports."

While the government was pouring loans into Latin America before and during the war, private investors were infecting her with a rash of industrialization. United States capital, frequently in combination with local interests, ran up manufacturing plants—particularly for consumer goods such as textiles, processed food, and leather products. With prices uncontrolled, the profits were enormous. Costs were irrelevant; the output could not keep up with the demand in any event. Argentina alone increased the number of workers employed in industry from 462,000 in 1935 to 829,000 in 1941, while raising the value of her manufactured products from 3,500,000,000 pesos (about $5,700,000,000) to 6,300,000,000.

Besides government loans and private investments, a third kind of co-operation took place during this period between the United States and Latin America It consisted of United States technical aid for agricultural, health, and educational projects. This assistance imposed virtually no drain on our private or public capital resources.

In 1938 the United States established an Interdepartmental Committee on Scientific and Cultural Co-operation which now

agricultural stations. A major part of the effort was to go into crops which were either complementary to or non-competitive with our own Among these were cocoa, coffee, fibers, insecti-

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Ministers, a resolution was adopted favoring co-operation of the American republics to promote health, sanitation, and education. The foreign ministers considered such a program a sensible way to mobilize western hemisphere resources, since a disease-ridden, illiterate, and undernourished people would be of little help in war. "At this time," says a *New York Times* reporter, "some countries did not produce food enough for their own people. In others illiteracy ran as high as 75 per cent. Eighty per cent of the people had intestinal diseases, 10 per cent had malaria. One out of five babies died, and life expectancy was forty-five years."

Shortly afterward the United States established three government corporations which later merged as the Institute of Inter-American Affairs, a branch of the Office of Inter-American Affairs headed by Nelson Rockefeller. It was designed to provide technical and material assistance for such varied developments as hospital and school construction, sewage and water supply projects, elementary education, vocational training programs, and training in modern agricultural methods.

But after the war something went wrong. As the manufacturing centers of Europe and Japan came back to life, as a buyers' market replaced the sellers' market, marginal Latin American industries found themselves unable to bring about rapidly the increases in efficiency which were essential to a healthy develop-

layoffs of workers, attempts to reduce wages, social and economic unrest.

With little foreign exchange to pay for machinery or raw materials (a great part of it had disappeared in purchases of imported luxuries), industrialization slowed or halted. Currencies depreciated. Inflation injured merchants and industrialists, terrified and infuriated labor, suspended a Damoclean sword over Latin American homes.

The result was a swing back to revolution and dictatorship;

1948, says Sumner Welles, brought "political uprisings in Co-
... in Central
... uay, and
... bance in
Chile . . . a revolution in Peru. The junta installed in Lima by General Odría has thrown the labor leaders in jail. It has outlawed the Apra, a party which is neither fascist nor Communist, and which, with all its mistakes, has unquestionably tried to better the lot of the underprivileged, and particularly that of the Indian population. For the time being democracy in Peru has been stifled

Between the end of the Second World War and the end of 1949 there were twelve coups and revolts below our border. Relations with the United States were at a postwar low. The Latin Americans appeared to believe we had let them down.

Yet Latin America is obviously better off than she was before

...

ported scarcely $500,000,000 worth of goods from the other American republics. By 1944 the figure exceeded $1,500,000,-

...

vestment in 1947 alone," said the Institute, "was almost double the total for the period of 1940–45."

Living standards are higher in Latin America today than they

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But after the war something went wrong. As the manufacturing centers of Europe and Japan came back to life, as a buyers' market replaced the sellers' market, marginal Latin American industries found themselves unable to bring about rapidly the increases in efficiency which were essential to a healthy development. In many instances they were producing worse merchandise than their foreign competitors, at a higher cost. There followed in fast succession a zooming of tariffs, a drop in local demand, layoffs of workers, attempts to reduce wages, social and economic unrest.

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The result was a swing back to revolution and dictatorship;

such combinations might be possible—but only if the investors could be sure there would be effective compensation in the event of expropriation.

The Latin Americans—in the person of Dr. Alberto Lleras Camargo, former president of Colombia and more recently Secretary General of the Organization of American States—then realistically reminded their northern confreres that where there was no private capital, the state had to take over some economic functions whether it wanted to or not.

Dr. Lleras contended that "if there were new lands to colonize in the United States, the methods that would be employed for a second trek overland probably would resemble those used by the TVA much more than the hazardous onslaught that once took place on virgin soil by dint of wagon stages." He added that "when a town lacks electric power, that is not an occasion for political philosophy . . . the salient fact is that, in the absence of private capital for the project, everyone demands that the state provide a service too urgently needed to be postponed."

The council finally went on record against discrimination between national and foreign investments by means of foreign exchange controls and punitive taxes; against seizure or expropriation without adequate compensation; against barriers to entry of necessary technical and administrative personnel; and against unnecessary government competition with privately financed enterprises.

One American businessman did not wait for the government of the United States to pave the way for him before investing his capital in Latin America.

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were before the war. Yet the people are miserable and resentful.

Perhaps the moral for Bold New Programmers is that you should not start teaching a man to swim in deep water if you are not willing to stay close to his side until he has learned.

It is interesting that the first practical proposals for putting the economic aspects of the Good Neighbor policy back on its feet came not from politicians but from businessmen. Business had a great and growing stake in the welfare of the southern republics. The greater part of $900,000,000 sent abroad by United States investors during 1948 went to Latin America. Growing social unrest and frequent revolutions represented hazards to these and earlier investments. Intervention being a quarter of a century out of date, the most practical alternative was to help recreate economic health in Latin America.

When asked for suggested medicines, some Latin Americans proposed a western hemisphere version of the Marshall Plan, with the United States extending vast government funds for Latin American recovery. The idea did not appeal to the North American business community. It tended, rather, to agree with Kirkwood Donavin, executive secretary of the Inter-American Council of Commerce and Production. Donavin suggested at a plenary session of the Council in September, 1948, that while small interest-bearing loans from the Export-Import Bank might be beneficial "for the express purpose of developing basic conditions, such as hydroelectric power, transportation, and rejuvenation of soil," other economic development should be left to private enterprise. The North American objection to regional Marshall Plans was summarized at the same meeting by James S. Kemper, chairman of the Lumbermen's Casualty Company, who pointed out that these "contemplate economic arrange-

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One Latin American speaker proposed great pools of private capital to finance industrial development, as an alternative to government loans. The general United States reaction was that

Latin American self-help that at the end of the war he established two corporations aimed specifically at strengthening the basic economies of underdeveloped areas, beginning in Venezuela and Brazil. Rockefeller did not start by setting up factories; before you can have sound industrialization, he believed, you must have sound men and women, sound communications, sound agricultural techniques. These he set out to develop.

The International Basic Economy Corporation and the Venezuelan Basic Economy Corporation now operate on $7,000,000 from the Rockefeller brothers and $11,000,000 supplied by the Venezuelan government, American corporations, and individual investors. By 1949 there were nine operating companies, each following the basic Rockefeller formula—millions for self-development but not one cent for charity. Company experts asked Brazil and Venezuela, "What industries do you need? What are your bottlenecks?" They then decided whether the situation could be improved at a profit—and frequently found that it could.

A few IBEC and VBEC operations:

1. Brazil needed more grain. Rockefeller took over a farm in Santa Rita, São Paulo, and planted it to a disease-resistant, hybrid corn which he sold to farmers. It increased their yields by 20 per cent.

2. Shipped in sacks, grain rotted. Handling costs were astronomical—65 cents and more a bushel. Rockefeller built elevators where corn could be dried and fumigated for bulk shipment. The result: handling costs are expected to drop more than 50 per cent.

3. In 1947 half of Brazil's hogs were killed by cholera. Rockefeller imported a new breed of hog, cholera-proofed. On a 300-acre farm his men showed how hogs could be raised more efficiently. Soon farmers all over Brazil were beginning to buy Rockefeller hogs and adopt his techniques.

4. Brazilian farmers as a clas[illegible] d machinery to plow their land, terrace their far[illegible] fields, spray their crops. Roc[illegible] r provides [illegible] it out on a contrac[illegible] d crews to[illegible]

panies which fail to make a profit will be liquidated. A company which cannot make money on its merits, in Rockefeller's belief, is no good to itself or anybody else. But he is not too worried. He approached the end of 1949 with his entire operation in the black—and 1950 looked better yet. "He would have to be terribly inefficient," commented one observer, "not to be able to cut food handling costs in the tropics."

"We want capitalism to serve as an irrigation system for the financially arid areas of the world," Rockefeller is fond of remarking. It would perhaps be more exact to say that he wants capital investment to serve as a well which, driven deep enough, will tap the underground springs of those arid areas. For in the end they can live and prosper only according to their own resources and potentialities. What outside capital can do, given the proper circumstances, is to let the resources and potentialities gush forth.

Of the three forms of United States government co-operation with Latin America, the one which is least costly, and which has seemed to work most successfully, has been that of technical aid. The ten-year-old Department of Agriculture program, for instance, has cost this country less than $400,000 a year; yet by 1949 it had resulted in research and demonstrational projects in 15 Latin American countries—Argentina, Bolivia, Costa Rica, Brazil, Colombia, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Mexico, Nicaragua, Panama, and Peru.

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The Institute of Inter-American Affairs could present an equally impressive record of achievement. A government-owned corporation since August, 1947, it has been operating under Dillon S. Myer on the modest budget of $5,000,000 a year. The IIAA employs about 300 men and women, of whom two-thirds spend their time in other American republics helping direct the work of 10,000 Latin American technicians on several hundred active projects. Control of each program is exercised locally through a special department in the appropriate ministry of health, agriculture, or education, with the head of the United States field party generally administering it. Programs usually run from three to five years, American aid in each case being covered by a contract between the host country and the Institute. A long-range sanitation program in the Amazon Valley is expected to require ten years before the water supply and sewage systems are ready for Brazilian operation and maintenance.

Typical projects are those in Colombia and Paraguay. The *New York Times* on February 22, 1949, reported:

> In the Colombia health project a field party of seven persons from the United States gives consultation service to 255 Colombian professional and technical personnel and 350 unskilled workers. Eight hospitals and ... health centers have started programs for ...

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Latin American governments were so delighted with the results in increased production of better crops that they increased their financial support from $500,000 in 1943 to an estimated $1,178,000 in 1948—an average of about $3 for every $1 put up by the United States.

The Department of Agriculture was delighted, too. Co-operation was paying out not only through better relations but also through better trade, for the revenue from the new crops tended to go for services and goods from the United States. It was decided to extend agricultural assistance to countries of the eastern

hemisphere as well. Missions were sent in 1949 to Afghanistan, Iran, the Philippines, Siam, Syria, China, Lebanon, Iraq, Saudi-Arabia, Egypt, and Greece.

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Latin American countries again indicated their approval in the most unmistakable way—by carrying most of the expense.

Here was an inexpensive program which really worked, and which rather than pap-feeding its recipients stimulated them to further effort of their own. Here, in fact, was a working prototype of one vital phase of the Bold New Program. It was so recognized by President Truman in February, 1949, when he asked Congress not only to extend the life of the IIAA for five years (its former charter was to expire July 1, 1950) but to increase its budget from $5,000,000 to $10,000,000 a year. The President commented:

> These are programs that, over the years, have been tried, tested, and found good. . . . I stated recently that we must embark on a program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas. Within the western hemisphere we have already built firm foundations for this program, and have already begun to demonstrate the benefits that can flow from such a program. . . . Each of the American republics, the United States included, is helped in its own progress by the improvement of economic, social, and cultural conditions in the others. By continuing this international co-operation for raising the standard of living for all the peoples in the Americas, the United States can give further, practical form to the high purposes of our policy.

The emphasis of Point 4 on technical aid, and the suggestion that in general the function of the American government shall be to furnish technical leadership while the co-operating coun- [illegible] consider granting such inducements as special income [illegible] ductions to American investors who participate in socially useful projects abroad, it is because otherwise they may put their money into socially useless projects—or not invest at all. Bilateral treaties to assure investors in underdeveloped areas against abnormal risks, to guarantee the convertibility of profit into dollars, to limit double taxation, are similarly the product of common sense backed by fresh Good Neighbor experience. It

better served if she had worried about producing eggs before she worried about producing rayon cloth.

The striking aspect of our experience in Latin America, however, is perhaps not that it has accomplished so little but that it has accomplished so much. That Latin Americans have been going through a postwar readjustment is less significant than the fact that the readjustment leaves them on an economic plateau considerably above that of 1939.

Many of their griefs and fears may be compared to those of a yachtsman who, after years in a bay, ventures out into the open sea. There is no easy and foolproof way to gain the confidence and skill he requires; but in venturing forth at all he has taken the one indispensable step. To ignore the recent advances of Latin Americans because of old problems still unsolved or new problems now arising would result in doing nothing because of all that remains to be done.

This is far from saying that Latin America's problems are not real and serious. They are. But the whole course of industrialization, as any recently industrialized country can remember, consists of one stormy crisis after another.

It may be hoped that as bellwether of the Bold New Program the Good Neighbor Policy will receive fresh and thoughtful attention in the months just ahead.

That attention might profitably turn to a three-year program recently put forward by an anonymous United States official with several decades of experience in Latin America. His omnibus approach includes the following proposals:

1. The earmarking of some official funds for "sound co-operative projects in Latin American countries which will agree to do something tangible to encourage United States and other foreign investments."
2. Easing income-tax requirements for corporations and individuals doing business in Latin America.
3. Insuring private United States loans for trade and industry.
4. Expanding the medical and sanitary program of the In-

stitute of ...

5. Encouraging industrial fellowships for Latin Americans with United States firms and corporations

6. ...

... says the official, ... should be an investment and not a gamble or loss. Let us offer it voluntarily in exchange for the liberalizing of certain nationalistic practices in Latin America and the encouraging of private capital, not with the idea of ...

... and world interests."[1]

Whatever the form that future co-operation with Latin America may take, one point is clear. ... and technical ... exter... Ame... tal them... icated or... free from... then the ... National Association of Manufacturers estimates, we were to have $2,000,000,000 a year of private capital available for foreign investment each year after 1952, and if all those $2,000,000,000 went to Latin America, letting the rest of the world go hang, that huge sum would still be only a drop in the bucket. Capital sowed by the wayside and in stony places will vanish with no worthwhile results.

But sown in good ground, the money which Americans can

[1] New York Herald Tribune, January 26, 1949.

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3. Insuring private United States loans for trade and industry.
4. Expanding the medical and sanitary program of the In-

stitute of Inter-American Affairs, and creating machinery to handle activities which fall outside the scope of present agencies.

5. Encouraging industrial [illegible] [illegible] ... grants are matched by [illegible] countries benefited.

"Such a program, properly correlated," says the official, "should be an investment and not a gamble or loss. Let us offer it voluntarily in exchange for the liberalizing of certain nationalistic practices in Latin America and the encouraging of private capital, not with the idea of making over Latin America in our own image but solely of helping it to stand on its own feet by eradicating the cancer of economic insecurity and low living standards with which it is now afflicted. And in so doing we will remove an element of instability at our very doorstep and foster common hemispheric and world interests."[1]

Whatever the form that future co-operation with Latin America may take, *one point is clear.* The value of the money and technical assistance we furnish will be dependent on the extent to which it wakens the creative energies of the Latin Americans. Eventually they must find most of the needed capital themselves. If the future of Latin Americans is to be predicated on the amount of money, public or private, that we can free from domestic purposes for use outside our own border, then they have no future. If, as the National Association of Manufacturers estimates, we were to have $2,000,000,000 a year of private capital available for foreign investment each year after 1952, and if all those $2,000,000,000 went to Latin America, letting the rest of the world go hang, that huge sum would still be only a drop in the bucket. Capital sowed by the wayside and in stony places will vanish with no worthwhile results.

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PART II

Introduction

WHEN THE Portuguese navigator António Galvão proposed in 1550 that a canal be dug across the Isthmus of Panama, he could not know it would take three hundred and sixty-four years to bring his scheme to completion. By 1880, when work was actually begun by the Frenchman Ferdinand de Lesseps, the necessary engineering techniques were widely available; but even then the project failed because of extravagance, corruption —and yellow fever.

Before there could be any practical prospect of completing the Panama Canal, there had to be sanitation, liquidation of disease, modernization of railways, provision of an adequate food and water supply, recruitment and training of a skilled working force, establishment of a capable administration. Without these, investment of magnificent engineering skill and billions of francs in the digging of the great ditch was like trying to catch water in a sieve.

In many underdeveloped areas of the world today it would be similarly pointless to start at once pouring huge sums of money into engineering or industrial projects. First the sieve must be caulked. The World Bank, with hundreds of millions of dollars ready to invest, is held back not by lack of desire but by lack of bankable projects. The fact that a nation applies for a loan of $50,000,000, or $500,000,000, is by no means proof that the money would be put to good use.

Today the opportunities for either government loans or private investment abroad for industrial development are limited. They are limited by hostile attitudes toward foreign capital. They are limited by some recipient countries' lack of dollar exchange. They are limited by local weaknesses in health, labor supply, food, fuel, transportation, purchasing power, public administration.

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is the best possible business. These are important lessons. By passing them on we can promote an industrialization that is humane rather than brutal. We can prevent the imposition of advanced techniques on an unready people—an imposition which is likely to lead to either tyranny at home, as in the case of the Soviet Union, or imperialism from abroad.

Under a dictatorship it may be possible to implant a heavy industry on a farming population with no in-between steps. In a democracy, however, that is an unlikely process, because heavy industry is an investment in the future. Of itself it fills no bellies, puts clothes on no backs, roofs no houses. Light industry, producing consumer goods, tends to precede or accompany it.

And there have to be roads, to get farm goods to market. And even before roads there have to be improvements in the farms themselves. Without a healthy farm economy, money invested in ambitious factories would be probably lost and certainly more harmful than beneficial in its immediate effects.

"What people need to realize," comments Norris E. Dodd, "is that you don't start with vast, expensive projects of modernization. If we could bring half the world from the era of the sickle to the era of the scythe, we would have moved ahead one hundred years in one jump."

Reduction of waste in storage, for instance, recently increased the grain available to Guatemalans by a fourth, before any increase in output. Experiment stations in China have taught prevention and cure of poultry diseases to tens of thousands of peasants, who to learn the new techniques were willing to walk miles with sick chickens hung over their backs.

On a 1949 tour of world food-producing areas, Mr. Dodd found that rice in India was still being laboriously threshed entirely by hand, though in Japan a little machine made of galvanized iron and a few nails had greatly increased the speed of the operation. General Douglas MacArthur, at Mr. Dodd's suggestion, presented one of these hand-threshers to an Indian representative in Japan. India is now adapting them for her

Industrial investment, public or private, requires improvement of these basic conditions. It requires competent and thorough engineering plans. It requires competence in administering economic and fiscal policy.

The chapters which follow therefore cover two separate stages in the evolution of Point 4 and the Bold New Program. They *give examples in many lands of the great development projects* which have been proposed and in some instances undertaken; *but they list also the improvements in basic economy* which form the indispensable framework for most of these developments.

Point 4 will have a system of priorities. In the first years its application will be limited. There will not be technicians enough *to go around. There will not be money enough.* Even as technicians and money become available, great areas of the world will remain shut off from the benefits of the Bold New Program by their own volition. Point 4 will not operate in China, for instance, or Russia, or Eastern Europe.

But these areas (though by no means all the countries in them) will be touched on in the following pages, because the need of a Russia or a China for the principles behind Point 4 is no less urgent than the need of Africa or the Middle East. Western Europe, too, will be examined; the joint principles of technical improvement and private investment are as applicable to developed as to backward areas.

Economic development is a process of generations. It starts slowly.

The readying process, moreover, cannot be simply one of teaching technical skills. Hearts as well as minds need tilling and fertilization. In our own haphazard industrialization Americans have learned many lessons that are unrelated to physical techniques. We have learned that industrialization is a social as well as an economic process; that it must serve the general welfare as well as the owner's pocketbook. We have learned that the widest possible spreading of the benefits of industrialization

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individuals the benefits of mass purchasing power; they lack credit societies to make money available for needed goods and equipment; they lack roads to take their produce to market. The productive energy of 300,000,000 of the world's people is minimized by malaria; another [illegible] [illegible] 1,000,000,000 [illegible] read, cannot write, can scarcely add or subtract.

A program for basic improvements in health, agriculture, literacy, land tenure and social customs is the first essential for backward areas. In some instances it will be possible simultaneously to launch TVA-like projects to harness unused natural and human resources. Many of the most widely discussed development programs, however, are still a number of years in the future. Says the United Nations Department of Economic Affairs:

> First, many of the programs are more impressive on paper than in reality. There are many obstacles to overcome between drawing up a program of action and executing it in terms of bricks and mortar.
>
> Second, many problems are of such pressing nature that action has to be taken quickly, often without a full appraisal of its effects in related fields. Even though such action may occasionally delay the elaboration of a comprehensive and closely interwoven scheme, this course may be worth encouraging since even small beginnings can be important in opening the way to larger undertakings in the future.[1]

The dream must still precede the doing. If the men and women of underdeveloped areas had lost the capacity for dreaming, their lot would be hopeless. They have not; and what they have dreamed will some day become reality, as surely as António Galvão's dream turned into the Panama Canal. With our aid and fellowship, moreover, projects that might have waited for centuries can be accomplished in decades.

When the basic economies are ready, industrialization of

[1] *Economic Development in Selected Countries* (Lake Success: United Nations Department of Economic Affairs, 1947).

peasants. During the next ten years, the hand thresher may have more effect on India's rice production than any of her great irrigation projects.

Rice is the staple of half the world's people. If the rest of Asia could attain rice yields approximating those of Japan, output of the Far East would rise from 130,000,000 to over 300,000,000 tons. Such an increase is possible through improved rice varieties—and nutritional value can be increased still further by better milling practices.

The first and indispensable job is the caulking of the sieve. Point 4 will therefore disappoint those who feel that the world [illegible] re- [illegible] ief. Some of these persons blame Point 4 not only for seeking ultimately to enlist American businessmen, a step which they appear to consider as obscurely criminal, but for being generally too cautious, too piddling. They blink at the fact that many of the industrial and technical accomplishments in which Americans take the greatest pride would not yet be applicable to all underdeveloped countries; that the needs of many of these countries are relatively simple, while we are accustomed to working with complex machinery; that in the first stages of Point 4 perhaps not more than 20 per cent of our famed know-how will be directly applicable abroad.

Many backward areas have no idea themselves of their economic potential. A State Department survey recently showed that of 32 countries in Latin America, the Middle East, and East Asia, only two had reliable employment figures. Only eight knew the amount of their external trade or national income, or their quantities of livestock. Just as India, for instance, has little idea of how much beryl, mica, and other rare minerals are available there, so Brazil is but vaguely aware of the tremendous oil shale deposits that exist under her forests.

Many underdeveloped countries literally do not know how to increase their food production, how to save their soil and trees, how to make use of their water, how to safeguard their cattle, how to catch their fish. They lack co-operatives to give

individuals the benefits of mass purchasing power; they lack credit societies to make money available for needed goods and equipment; they lack roads to take their produce to market. The productive energy of 300,000,000 of the world's people is minimized by malaria; another [illegible] of [illegible] [illegible] ... add or sub- [illegible]

A program for basic improvements in health, agriculture, literacy, land tenure and social customs is the first essential for backward areas. In some instances it will be possible simultaneously to launch TVA-like projects to harness unused natural and human resources. Many of the most widely discussed development programs, however, are still a number of years in the future. Says the United Nations Department of Economic Affairs:

> First, many of the programs are more impressive on paper than in reality. There are many obstacles to overcome between drawing up a program of action and executing it in terms of bricks and mortar.
>
> Second, many problems are of such pressing nature that action has to be taken quickly, often without a full appraisal of its effects in related fields. Even though such action may occasionally delay the elaboration of a comprehensive and closely interwoven scheme, this course may be worth encouraging since even small beginnings can be important in opening the way to larger undertakings in the future.[3]

The dream must still precede the doing. If the men and women of underdeveloped areas had lost the capacity for dreaming, their lot would be hopeless. They have not; and what they have dreamed will some day become reality, as surely as António Galvão's dream turned into the Panama Canal. With our aid and fellowship, moreover, projects that might have waited for centuries can be accomplished in decades.

When the basic economies are ready, industrialization of

[3] *Economic Development in Selected Countries* (Lake Success: United Nations Department of Economic Affairs, 1947).

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organism may have had grave defects, but it was a living creature, complete in all its parts. The pattern for the future in most underdeveloped areas will include a far greater degree of government planning and control. There will be frequent and strong temptation to impose industrialization by fiat on a relatively unready region. That is a delicate and risky business. The architect may design a fine heart, stomach, and bowels, but forget the lungs or the white corpuscles. Or like Frankenstein he may omit the soul and so create a monster.

It would be easy, in our preoccupation with the ultimate aims of the Bold New Program, to shrug off the painstaking work which must come first. It would be equally easy, in attending to all the necessary details, to lose sight of the great objective we are seeking. The nicety with which Point 4 avoids these opposite errors will be the measure of its failure or success.

6

Latin America in Flux

RECENTLY VICTOR RAUL HAYA DE LA TORRE, leader of Peru's Apra Party, visited Albert Einstein at Princeton. While the scientist solemnly nodded agreement, Haya de la Torre expounded a theory of relativity applied to history: the United States and Western Europe, he said, live in the twentieth century, as does coastal Peru; but Peru's Indian highlands are sixteenth century, and the Amazon Basin is still prehistoric. Haya de la Torre concluded that programs for developing backward areas cannot be applied by rule of thumb, but must vary according to the historic stage of each region involved.

It is obvious that the 20 Latin American republics differ tremendously in climate, man power, resources, economic and social progress. Argentina, Brazil, Chile, Cuba, Mexico, Uruguay

... whole, two-thirds of the inhabitants depend on agriculture for a livelihood—most of them subsisting entirely on what they can grow themselves. In 1938, when the per capita income of Americans[1] was $518, that of Argentines was $156; of Chileans, $126; of Mexicans, $60; of Bolivians, $39; of Brazilians, $33.

As a group, however, these underdeveloped lands are among earth's richest storehouses. Latin America supplies the world with all its bananas, coffee, and sisal, with "43 per cent of [its] silver, 31 per cent of its cocoa, 26 per cent of its sugar, 20 per cent of its copper, 20 per cent of its hides, 18 per cent of its tin, 16 per cent of its wool, 15 per cent of its petroleum."[2] Rubber is indigenous to the Amazon Valley, and natural nitrates are to be found only on the west coast of South America.

This storehouse occupies some 9,000,000 square miles of the earth's surface—three times the area of the continental United States. Its population, like ours, is about 150,000,000, which means that we support three times as many inhabitants per square mile as Latin America does. The majority of Latin Americans are of mixed white and Indian blood. In some countries, such as Brazil, there is a considerable Negro admixture. In others most of the people are pure white.

But disparate as the Latin Americans are, they have an obsession in common. They are determined to pull themselves into the twentieth century, by their bootstraps if necessary. Every Latin American government, however small and poor the country may be, has its own plan of economic and industrial development.

Some, indeed, have even cut across national boundaries to achieve common goals. The Greater Colombia Merchant Marine, for instance, is owned 45 per cent by Colombia, 45 per

[1] Forgive me for eschewing the cumbersome—and itself imprecise—phrase "North Americans" when referring to citizens of the United States.
[2] Op. cit.

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have passed through the initial stages of industrialization. Central America is still virtually 100 per cent agrarian.

In Latin America as a whole, two-thirds of the inhabitants depend on agriculture for a livelihood—most of them subsisting entirely on what they can grow themselves. In 1938, when the per capita income of Americans[1] was $519, that of Argentines was $156; of Chileans, $126; of Mexicans, $60; of Bolivians, $39; of Brazilians, $33.

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It is obvious that the 20 Latin American republics differ tremendously in climate, man power, resources, economic and social progress. Argentina, Brazil, Chile, Cuba, Mexico, Uruguay

government can hardly wait for their reports before planning new roads to tap and create new pioneer regions. Elsewhere, too, Peru is building trans-Andean highways and supporting the systematic development of such other resources as oil, minerals, forest products, and water-power.[4]

Most of the Latin American countries are seekin[illegible] their progress through natio[illegible] rations [illegible] [illegible] agricultural and industrial development which the United States carried out in a hundred and fifty years.

Let us see what some of the prospects are.

BRAZIL

At the opposite end of the scale from the private basic-economy endeavors of Mr. Rockefeller's IBEC are the tremendous modernization plans which have been promulgated by the Brazilian government. It is all very well, say the Brazilians, to put agricultural improvement before new industries; but as the third largest country on earth and the largest in the western hemisphere Brazil is going to industrialize while she agriculturalizes, or know the reason why. She is going to be economically independent, even if home-grown steel should cost twice as much [illegible] steel imported from the United States. In 1944 Brazil's Economic and Planning Commission laid down the broad outlines of a program designed to increase national income fivefold—from 40,000,000,000 cruzeiros (about $2,200,000,000) to 200,000,000,000 cruzeiros—inside of fifteen years.

The defects of forced industrialization have come frequently and disagreeably to Brazilian attention. Recently, for instance, an American automobile manufacturer was approached to set up a plant in Brazil, taking advantage of steel produced by the great new Volta Redonda mill. He refused—because, he said, "I might be able to make my bodies and engines all right, but how about spark plugs? How about distribution systems? Those

[4] *New Worlds Emerging* (New York, Duell, Sloan & Pearce, 1949).

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was fired by the examples of Woolworth's and Macy's, and returned home determined to create a mass market by selling needed goods cheaply.

Even with the price of his wares marked down for quick turnover, however, sales were slow for lack of Brazilians with money. The obvious answer was installment buying—but that had been made a racket in Brazil and was in bad odor. Carvalho solved his dilemma by inventing Credario—"as dignified as a charge account, as convenient as an installment plan." Customers receive punch cards bearing credits for varying amounts, according to their financial standing. The card is to be paid for within ten months, meanwhile, the customer may wander at will through the store, buying all he pleases within the limit of his credit.

Credario offices were opened all over the city. A Exposição boomed. Today 70 per cent of its business is done on credit; 300,000 Brazilian families use Credario.

By 1940, A Exposição was the largest store in Rio. Brazilians had scorned ready-made suits. Carvalho set up a tailoring establishment and proved that ready-made suits can be not only as good as tailor-made suits but a lot cheaper. Brazilians did not give Christmas presents. Carvalho lured them into the habit by himself giving presents during the pre-Christmas season to everyone who made a purchase at his store. He had admired

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gross twice that. His workers receive top wages, free medical care, groceries at cost, pensions, an automatic raise of 50 cruzeiros ($2.70) a month for every child

And now he is laying plans for a business college where young Brazilians can learn modern business methods.

The story of Lauro Carvalho deserves thoughtful study, not because it sounds strange to Americans but because it sounds so familiar A nation that can breed a Carvalho is bound sooner or later to develop mass consumption—which means mass production And there can be Carvalhos in every underdeveloped area of the world.

To build Brazilian health, Brazilian literacy, Brazilian purchasing power, the government has entered on a program of many parts

Furthest advanced is the great new $70 000,000 steel plant at Volta Redonda, financed partly by the United States Export-Import Bank, partly by the Brazilian government, and partly ($16,500,000) by Brazilian individuals. With domestic steel, Brazil will be able ultimately to construct and operate her own railroads, launch her own industries, supply steel products to a hinterland that includes half of South America

A second Brazilian resource is the tumultuous flow of the San Francisco River, which at the Paulo Alfonso Falls has one of the most concentrated sources of hydroelectric power in the world. Morris L Cooke, who in 1942 headed the American Technical Mission to Brazil, has estimated its electric potential at 750,000 kilowatts.

Exploitation of the San Francisco would open all northeastern Brazil to immigration and industrialization So enthusiastic are the Brazilians over the prospect that they have taken the unprecedented step of writing a provision for the development of the San Francisco River Valley into their new constitution—and have set aside a fixed percentage of the national revenue to insure realization of the project.

The San Francisco, running parallel to the coast, provides a

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A canal at Chacaltianguis will drain the swampy, infested lakes to the north. Part of the $300,000,000 earmarked for the project will go toward control of erosion, floods, and such tropical diseases as hookw...

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electricity, ... Mexico's installed capacity by nearly 25 per cent. The population of the region—now less than 200,000—is expected to treble through immigration.

Between 1940 and 1945, Mexico increased the number of

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... and Indians who comprise 70 per cent of the 21,000,000 Mexicans; 14,000,000 Mexicans, virtually isolated by primitive communications, still exert no influence whatever on consumer demand. They are untouched by most health and social welfare projects. The Carnegie Institute, investigating a remote Yucatan area in 1941, found ...

... as an American had.

To help remedy this situation, the Federal Electricity Commission in 1947 launched a program aimed at installing by 1952 new electric plants with a capacity of more than 800,000 ...atts, at a cost of ...

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Broken into seven regional programs, Chile's eighteen-year plan calls for exploiting more than 6,000,000 kilowatts of electric power—as much as the present generating capacity of all France.

Already electricity is flowing from one of the most tremendous installations in South America—the great dam on the Rapel River, on which Chile has spent $50,000,000. Electrical generating stations are springing up all over the country.

Furnaces have recently started working in a Pacific Coast steel plant. New capacity amounting to 300,000 tons of steel yearly has been made available by an investment of $14,000,000 in Chilean reserves and $60,000,000 in foreign credits. Plants have gone up for construction of Portland cement and copper wire.

The National Electric Company is taking an active part in aiding industries, towns, and farm co-operatives by distributing motors, machines, and irrigation pumps on long-term, low-interest credits.

BOLIVIA

When [illegible]

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This principle of conditional aid, already familiar through the technical activities in Latin America of the Department of Agriculture, the Institute of Inter-American Affairs, and other agencies, is well illustrated by Bolivia's government-owned Development Corporation. Of its six [illegible]

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When President Truman asked Congress for $45,000,000 to start the Bold New Program on its way, he promised that "In every case, whether the operation is conducted through the United Nations, the other international agencies, or directly by the United States, the country receiving the benefit of the aid will be required to bear a substantial portion of the expense."

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walls to protect them, carrying through a series of six-year plans. Every day new plants are going up—fertilizer plants, coke plants, hydroelectric plants, sugar mills, packing and refrigerating plants Highways and railways are being built, harbors improved, pipe lines laid down

Much of the money for these developments has come from either the Export Import Bank or the International Bank for Reconstruction and Development. Since the task is barely begun, more capital will be needed A large part of it henceforth must come from private sources in the United States It appears that Mexico has reached a level of political stability making possible guarantees against further expropriations like that of American oil firms holdings in the 1920's At least that is to be hoped, for with only a sixteenth even of her water power resources in use, Mexico has a long way to go to achieve a modern and healthy economy

CHILI

Chileans claim that their country has the greatest per capita potential of hydroelectric power in the world - 1,300 watts per person, as opposed to a little over 200 (water power only) for the United States With a treasure like that waiting to be scooped up, the country which stretches like a twisted snake down the lower west coast of the continent has acted with vigor. As early as 1943 the Chilean Development Corporation launched a $100,000 000, eighteen-year program which was intended not only to electrify all railroads, factories, mines, and smelters, but to bring electricity to the remotest farm in the country.

Chile's principal coal mines, near the port of Concepción, are already depleted They have been sunk to a depth of 1,300 feet and punched three miles out under the sea on a five mile front. Electricity can ease the drain on these shrinking resources. And electricity will draw up subsurface water in the great, rainless Atacama desert, giving its fertile soil the productivity of a second Imperial Valley The dams built for hydroelectric power can also store the central valley rains, which fall contrarily in

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gressing upon spheres of activity which are within the scope of private initiative. This goal is to be pursued by undertaking works which, because of their magnitude or a lack of immediate profit, fail to attract the ordinary investor; private industries and undertakings are to be encouraged in every possible way." As in the case of Brazil's San Francisco River development, some federal revenue (about $200,000 a month, which for Peru is a lot of money) has been assigned to the corporation. Projects completed or now being carried out include the establishment of iron and steel industries with a yearly output of 55,000 tons; exploitation of Peru's generous coal reserves, development of port installations in Chimbote Bay, irrigation; and hydroelectric power.

Where the Santa River crosses a semi-desert on its way to the sea, 250,000 acres are being irrigated. To furnish electricity for their projected industries the Peruvians have diverted the course of the Santa River and exploited the waterflow of the Cañon del Pato, using underground galleries excavated through 6 miles of solid granite. The Santa hydroelectric project calls for an ultimate production of 125,000 kilowatts, of which 50,000 are already at work.

Other still more ambitious hydroelectric schemes have been surveyed by the Peruvian government one for the Urubamba River, which will have 120,000 kilowatts capacity, one on the Mantaro, with 740,000 kilowatts, and one on the upper Marañón, with the staggering total of 2,000,000 kilowatts. The latter project may some day transform the economic structure of all northern and northeastern Peru.

PUERTO RICO

Though Puerto Rico is an island dependency of the United States, she is pre-eminently Latin American, and during the past ten years she has undergone a metamorphosis which holds out hope for every underdeveloped area of the world.

The United States has 50 inhabitants per square mile. Puerto Rico has 400 Poverty-stricken, undernourished, sickly, the

tion, even after committing itself to a developmental loan, the Bank may withhold payment until a substantial sum has been invested by the Bolivians themselves.

Mexicans and Chileans are busily inventing new stratagems to speed the conversion of their countries into industrial states; Bolivia, by contrast, has no industry worth mentioning. A shrinking supply of tin and unplumbed deposits of petroleum constitute her principal immediate resources. Her present needs are less for factories than for improved agricultural production —and above all, since she has no access to the sea, for improved communications with the outside world.

When Alfalfa Bill Murray and Tex Rickard imported Oklahoma farmers to pioneer the rich grazing and farming lands of Santa Cruz in 1923, their mission failed because the imported Oklahoma farmers could not get their goods to market.

A U. S. mission in 1942 proposed that Bolivia spend eventually $40,000,000 on highways, as against only $15,000,000 on agriculture and $8,000,000 on irrigation. The United States Public Road Administration agreed to supply engineering aid. A key highway from Cochabamba to Santa Cruz, bisecting the heart of the country, is now nearing completion. By agreement with Argentina and Brazil, railroad lines will soon operate from Santa Cruz to Corumbá, Brazil, on the one hand, and to Yacuiba, Argentina, on the other, providing Bolivia at last with direct railroad access to the sea. The new roads will open one of the richest hinterlands in the world.

PERU

The Santa River, running parallel with the west coast of Peru, is tiny on maps but tremendous in its power for good. The basin is now being developed along TVA lines by the Peruvian Santa Corporation, which has sway over an area of 40,000 square kilometers, including a littoral with bays and islands.
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Puerto Ricans have long been literal skeletons in the U. S. closet. Wrote Governor Theodore Roosevelt, Jr., in 1929: "The inland districts, from the ouskirts of the cane-ridden valleys to the tops of the mountains, seethe with human misery, and it is impossible to pass into or out of any city or town without traversing the fringes of unsightly, malodorous, filthy habitations which surround the more prosperous areas."

Yet Puerto Rico has a beautiful climate, great agricultural resources—particularly in sugar—and a beneficent United States suzerainty. Indeed, little squalid Puerto Rico in 1936 was the sixth best customer of the United States outside our own continental borders, while Americans in turn eagerly bought Puerto Rican sugar, rum, tobacco, and citrus fruits. Wages of sugar workers, however, averaged less than $150 a year—and sugar workers were the aristocrats of Puerto Rican labor. Despite a basic law providing that no corporation or individual might own more than 500 acres of Puerto Rican land, absentee landlords frequently possessed sugar estates of 50,000 acres. Puerto Ricans claimed that since the American-owned sugar industry in fifteen years had received $100,000,000 in dividends on an investment of $40,000,000, it was clear that the industry was draining rather than bettering the Puerto Rican economy.

When the United States Supreme Court recently upheld the ... of breaking ... ne back to ... o co-oper- ... roduction of electricity almost trebled in Puerto Rico. Tax revenue in 1949 was 260 per cent higher than in 1940. Puerto Rico's Industrial Development Corporation set about getting private funds for investment where it could; but it used public funds when private funds were not available. It built a glass factory to make bottles for Puerto Rican rum, took over a cement mill, set up plants to make paperboard from the leavings of the sugar industry. It is making factory buildings at its own expense and leasing them to private investors with options to purchase. Taxes are remitted for new industries.

Virtually every Latin American republic or possession has its own *Corporación de Fomento*—a development corporation owned in whole or in part by the government and usually aimed specifically at the development of natural resources. By such means Colombia is creating new chemical, metallurgical, and electric industries; Uruguay is tapping the Río Negro for electric power; Venezuela, concentrating on its most urgent problems, is seeking to variegate industries and increase agricultural and livestock production.

But to produce lasting benefits, a development program must begin at the beginning. There can be no healthy country without healthy human beings, fed body and mind; there can be no healthy population without a healthy land.

Point 4 will provide technical aid to Latin America on her engineering projects. Simultaneously it will work on the beginning things.

Brazil, for instance, has an infant mortality rate that is five times our own. In all Mexico there were in 1949 only ten well-trained public nurses, while 62 per cent of its homes lacked either sanitary sewerage systems or a potable water supply. Most of the towns in Bolivia have no running water. Ten per cent of the French Guianans suffer from leprosy, as do thousands in Ecuador. Smallpox infests the tropics. Venereal disease is so prevalent in Latin American ports that sailors are three times as likely to catch it there as elsewhere in the world. In some parts of Ecuador the incidence of malaria runs as high as 75 per cent. The Amazon cannot be settled until jungle yellow fever is whipped; the fever, moreover, is creeping northward up the route of the Inter-American highway. Smallpox cannot be wiped out until we have found a heat-resistant vaccine which can be transported in the tropics without refrigeration.

Improved physical health in Latin America is one pre-condition of improved economic health. The United States has the [illegible] this pre-condition as a college [illegible] from coming down with a [illegible] Latin American economy, it will be easier to bring about a healthier world economy.

years they had developed two specifics which are wiping out the disease.

Similar Point 4-type projects are going ahead in irrigation [illegible]

training. Rural Latin Americans will be learning how to construct such undramatic and essential objects as sanitary privies. They will learn new treatments which render leprosy non-infective. Demonstration clinics in Latin American ports will ferret out the roots of venereal disease, develop programs for combating it.[10] DDT will hover about the walls of city and rural homes alike, destroying the mosquitoes that carry malaria. Technicians are counterattacking jungle fever, experimenting with new smallpox vaccines.

Point 4 may not itself finance great factories, but it will establish pilot plants for production of vitamins from Venezuelan fish, and laboratories to improve the market value of Paraguayan wood. It may not finance great dams, but it will give [illegible]

[illegible] grade manganese deposits near Corumbá and Amapá, Brazil. U. S. experts are assaying Brazilian oil shale beds. They are examining soil formations in Panama which appear identical with the oil-rich sands of Venezuela. In Mexico they are finding [illegible]

[illegible] ican stock-piling program.

[illegible]

years they had developed two specifics which are wiping out the disease.

Similar Point 4-type projects are going ahead in irrigation and land reclamation, industrial techniques, mining and metallurgy, labor productivity, transportation, and education. Their tempo will quicken and their scope will increase. By the end of 1950 dozens of operations will be under way in public health training. Rural Latin Americans will be learning how to construct such undramatic and essential objects as sanitary privies. They will learn new treatments which render leprosy non-infective. [illegible]

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[illegible] manganese deposits near Corumbá and Amapá, Brazil. U. S. experts are assaying Brazilian oil shale beds. They are examining soil formations in Panama which appear identical with the [illegible]

new d[illegible]

In Ve[illegible]

asbest[illegible]

ican s[illegible]

Latin Americans and Latin American governments are not likely to agree that more elaborate development projects must be

[14] More than 25 per cent of the cases of venereal disease recorded in Sweden originate among sailors. In Rotterdam the figure is 43.6 per cent. A high proportion of these cases originates in Latin America.

Most important of all—difficult, indeed, to overemphasize—is the simple fact that work is actually going on. Roads are thrusting into the wilderness, power lines are creeping across deserts, factories are uttering smoke, farmers [illegible] proved feed [illegible] is proceedin[illegible] and go, whi[illegible] or thrown out of office, while statesmen negotiate and politicians dicker.

Latin America has rubbed Aladdin's lamp. By 1955 Mexico, Chile, Brazil, and Argentina alone will have 5,000,000 kilowatts more of installed power than they had ten years before. They will have added the equivalent of a full-time slave for every man, woman, child, and babe-in-arms of all four countries. There will be more food in Latin American bellies, better clothes for Latin American backs, more pesos jingling in Latin American pockets. While we wince at the growing pains to the south of us, the growth will continue. We cannot stop it if we would.

We can, in some measure, give the benefit of our experience. We can help to guide our neighbors toward democracy rather than statism, toward freedom rather than slavery, toward friendship rather than distrust. Our money and skills can provide them with the start they need

But however useful we may be in the future of Latin America, we are not indispensable And that is quite as it should be.

7

Africa — Not So Dark

In the bush and forest lands of Africa there dwells a dragon which slays its thousands in the heat of the day, striking down man and man's beasts with fine impartiality. It has rendered tracts the size of an average European state uninhabitable. The monster is a brown, mottled fly a little larger than a bluebottle —a fly which horribly lays no eggs, but brings forth at intervals a fully developed, wriggling larva. The tsetse fly lives by sucking blood, and where an infected fly has sucked, there death

of their development corporations work closely with American technical missions.

Like other areas which seek rapid industrialization, Latin American countries tend to adopt methods which in the short range impede multilateral trade in favor of immediate national interests. As factories go up workers earn more money, and have to be stopped from spending it on foreign luxuries instead of turning it into domestic investments. Barriers are erected against goods from abroad which compete with new local manufactures.

It is this hunger for economic independence which has led Brazil, Argentina, Chile, Peru, Mexico to set up their own steel mills, even when they will have to pay higher prices for the domestic product than they would for American or European steel.

These are complex matters, in which instinct often battles with reason and long-term with short-term interest. They will never be adjusted to the complete satisfaction of everyone concerned. Nations which are industrially further advanced will be annoyed; they will have to draw on their stores of patience as well as on their bargaining powers.

In the end, however, protective devices taken by the newly industrializing states are unlikely either to bring their industrialization to a halt or to drive them permanently outside the economic comity of nations.

Americans must accept also that Latin American development programs generally are and will continue to be government-directed. Every country has its five-, ten-, or twenty-year plan. The programs are designed to further the general welfare, not to abet either statism or private enterprise; but "it is regarded as a responsibility of government to create a general framework or 'economic climate' designed to assist and foster economic development."[12]

12 *Economic Development in Selected Countries*, XV (United Nations, Lake Success, 1947).

The population of ... is st... tive: ...

1,000 apiece. The 1,400,000 natives earned $12,000,000—8.30 apiece, of which 35 to 40 per cent consisted of the self-ubsistence output of the jungle farmers. It must be added, of ourse, that the Europeans lacked the advantage of such nourshing dishes as caterpillars, which form a useful part of the Africans' diet.

Forty per cent of the 500,000,000 horsepower of electric energy available in the streams of the world flows in Africa—and only a hundredth of that African potential has been developed. Of the major minerals needed for industrialization, East

The New York Times has described Africa, with the Middle East, as "the present-day magnets for American capital seeking investment outside the United States."

One reason for this interest is simply that despite increasing

... the United States.

In 19... nea... alor... ing... 000 ...

... Africans

blossoms. The fly transmits the parasite of trypanosomiasis, which brings death to livestock and the slow disintegration of sleeping sickness to humans.

In modern times, the African continent itself has seemed to be a victim of sleeping sickness. The disease is characterized, says the *Encyclopedia Britannica*, by "protracted lethargy, fever and wasting." While the rest of the world has stumbled or run toward whatever destiny awaits it, Black Africa has slumbered uneasily and restlessly in the sun.

But today Black Africa is sitting up, rubbing its eyes, looking curiously and sometimes resentfully around it at the modern world.

Symbolic of the change is the recent advance of science against the tsetse fly. Imperial Chemicals Industries, Ltd., the same British concern which perfected paludrine as a specific for malaria, has developed a white, water-soluble powder which in 1949 alone immunized 2,000,000 head of cows, camels, and horses against trypanosomiasis. The effectiveness of antrycide on humans is not yet proved; but it is known that it can open to livestock an East African area so great that all the beef needed for Britain can ultimately graze there.

Africa is a third desert, a third jungle, the balance largely high plateaus. It is the second largest continent, occupying a fifth of the earth's land area. It has, to be sure, only 7.5 per cent of the earth's population—but an overpopulated world needs living space. It produces only 3 per cent of the world's farm products—but its agricultural potential remains virtually untapped. It has only 5 per cent of the world's railroads and 5 per cent of the world's trade, but the lack is a measure of the opportunity.

Since the region is almost entirely undeveloped, it is virtually impossible to obtain accurate figures on its income. In Northern Rhodesia, however, a careful pilot study gives results which may be fairly projected to most of Colonial Africa.[1]

[1] Phyllis Deane, "Measuring National Income in Colonial Territories," *Studies in Income and Wealth*, Vol. 8 (New York: National Bureau of Economic Research, 1946).

hen there was to be a village containing its own store, school, and clinic.

In completed form the groundnut project was intended to double Tanganyika exports, with a consequent increase in imports of things to wear and eat and work and play with. It would thus result in a better life for the Africans while supply-

[illegible]

bor is untrained. . . . "The agricultural machines we first brought in were not suitable to the conditions we faced. . . . Some sites we selected had to be abandoned for lack of water. We realize now that the scheme is unlikely to help Britain solve her food problem. East Africa will consume a large part of the food we can produce. If we ever do get an export surplus, it can find markets much nearer than the British Isles."

And while the British were investing tens of millions of pounds in new peanut production in Tanganyika, 300,000 tons of peanuts were piled in pyramids at Kano, Nigeria—many of them rotting because the Nigerian railroad could not transport them

[illegible]

Tanganyika scheme received approval, experts would have checked the moisture and fertility of the soil, the access to markets, the availability of machinery and trained personnel—all

with money—and with pockets to put their money in—woul be a pleasant sight for us to look upon.

If American or any other investors should enter Africa wi the thought of finding here old-time, carefree colonial exploit tion, they would return home healthily disillusioned.

It may be questioned, however, whether even imperialist exploitation could be more damaging to the future of Afric than the expenditure of hundreds of millions of dollars on wel meant but ill-considered projects by European government One such project which appears largely to have belied its earl promise is the great Tanganyika groundnut (peanut to Amer cans) scheme of the British, under which land is being cleare for the biggest socialized farming experiment of the wester world

In the early days of the groundnut plan it was described b the *Times* of London as the boldest and most comprehensiv ever launched for developing backward territories"

The theory was beautiful The world is producing each yea some 6,000,000 fewer tons of oils and fats than it can use Britain alone needs another 1,000,000 tons a year. Unde Operation Groundnut this deficit was to be lessened by 600,00 tons. By 1956 Britain s Overseas Food Corporation was to hav cleared 5,000 square miles of virgin brush in Tanganyika, Ken ya, and Northern Rhodesia, 3,250 000 acres were to be plante to peanuts, sunflowers, and grasses

Mechanical arts would be taught to the more ambitious na tives. They would become tractor drivers operators of machine Eight thousand tractors, plus thousands of trucks, earth mover and bulldozers—many of them American leftovers from th war in the South Pacific—would be involved in peanut grow ing.

It was planned eventually to break down the operation int 107 fully mechanized farms of 30,000 acres each A farm would require comparatively few laborers – perhaps 70 skille Africans and another 230 day laborers For each force of 30

20's, Liberia granted large plantation concessions to the Firestone Rubber Company. The plantations may have represented a crushing pattern of economic colonialism; but they brought sanitation, schools, hospital services, low-cost foods, and opportunities for advancement to thousands of natives—plus a wage of 20-odd cents a day, far more than non-Firestone natives had ever earned.

During World War II the Americans built Roberts Field 60 [illegible] ng [illegible] on [illegible] and made recommendations for diversified development.

"Members of the missions reported with some surprise," com[illegible] with which the [illegible] items in their [illegible] t enabled them for the first time in years to meet the tax collectors with ready money. In a test-and-demonstration area of some twenty villages, the people—generally regarded as stubbornly conservative—adopted new farming methods with enthusiasm—as well as the few donkeys that the Americans imported to replace Liberia's traditional transport system of headloading by human carriers."

Liberia is a land of mighty forests—the largest left in West Africa; of abundant gold, of cacao, of sugar cane; of wild palm oils and fibers. The hinterlands contain unexplored deposits of iron, lead, copper, corundum, chromite, bauxite, manganese. Not until the enthusiastic report of the economic mission, however, did American capital (apart from Firestone) prick up its ears. Almost immediately an operator of a barge line in New [illegible]

the thousand and one factors on which the feasibility of such an undertaking depends.

An interesting parallel—and contrast—to the public-enterprise development of Tanganyika peanuts is the private-enterprise development launched in the Republic of Liberia by Edward R. Stettinius, Jr. In late 1947 Mr Stettinius' Liberia Company announced its intention of pioneering development of the country's natural resources along new and novel lines. The government was to receive 25 per cent of the company's capita stock, the income from it to go for basic improvements such a the building of roads. Another 10 per cent of the stock was set aside to provide a fund for the education of Liberians.

In return, the Stettinius interests received a virtual monopoly on many resources of Liberia. Subsidiaries were established to operate air lines, cacao plantations, refrigeration plants, trading companies.

But the company was spreading itself dangerously thin. Deprived of the magnetic leadership of Mr Stettinius by his death in 1949, it appears that the Liberia Company is due for a considerable scaling-down of its early program.

In the Stettinius scheme, as in the Tanganyika peanut farm, projects that loomed large on paper have shrunk in practice. In all likelihood major mistakes have been made. But Liberia Company mistakes were made at the expense of the entrepreneurs, not of taxpayers, and where schemes have gone sour they have been dropped. There have been no reasons of political prestig for bulling a project through to completion if it proved imprac tical.

LIBERIA

In 1822 a shipload of one time slaves from the United States established on the west coast of Africa the settlement which eventually became Liberia, only Negro-dominated republic in Africa. For a hundred years the westernized Liberians clung precariously to the coastline, battling interior tribes. Soon afte they had finally extended their control to the hinterland in th

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counterpart fund. The United States, which must be consulted before this fund is used, has approved the expenditure of large amounts on Africa.

Britain, France, Belgium and Portugal are the great landholders of Africa. Of the four, the Belgians and Portuguese are leaning most heavily on private capital for the modernization [illegible] capital is weaving a web of [illegible]

southeast, and Stanleyville in the north. Mining of gold, tin, copper, coal, diamonds, zinc, molybdenum, and manganese—not to mention Congo uranium, on which American sources draw heavily for atomic weapons—is being modernized. Ten million natives, most of whom now live in the bush, are to be drawn into the program, which will include projects in housing, education, and health. Lever Brothers is opening technical schools, starting sawmills and plywood factories, constructing and enlarging soap factories.

The Brussels government has set up a welfare fund of 2,350,-000,000 Belgian francs (about $847,000,000) for the Belgian Congo and the trust territory of Ruanda-Urundi. But to carry out extensive industrial and agricultural development, aid will be needed from the United States. Pierre Wigny, the Brussels Minister of Colonies, believes that comparatively small sums can set the ball of modernization rolling. The terms under which private American capital might become available for the Belgian colonies under Point 4 were discussed on a recent visit to Brussels by Winthrop Aldrich of the Chase National Bank.

[illegible]

surge of economic progress. She expects a foreign trade incr. of 25 per cent within the next five years.

Britain's Food Minister Strachey recently remarked t "The European Recovery Program cannot succeed if it remai a program confined to Western Europe; for Western Europe, itself and by itself, is not, and never can be made, an econom ally viable area. . . . The Old World of Western Europe *today most grievously out of balance, but we must call in a st* older world—the world of Africa—to redress that balance an in doing so, we must find the way of transforming Africa. A Africa based on the economics of the hoe will be a liability ar a drain on Western Europe. An Africa based on the economi of the tractor can become the indispensable partner of tl West."

The four great colonial powers in Africa—Britain, Franc Belgium, and Portugal—are engaged today in an all-out dri for the modernization of the dark continent. *In no small mea ure, the drive is dependent* on American aid.

ECA, for instance, has set aside $10,000,000 to explore Ea African mineral possibilities. ECA experts are giving advice c maintenance and repair of transportation networks. In 19 ECA granted $550,000 to the Rhokana Corporation of Northe Rhodesia to set up a modern plant for extracting cobalt fro

Under ECA, too, American technical experts are workin with the British in research on trypanosomiasis, malaria, an other insect-borne diseases. These technical programs will

of the major schemes. If Pierre Duclos of Lyons, for instanc wants to buy an American harvesting machine, he pays his ow government for it in francs. The government then pays th American seller in dollars which have been made available b ECA. But the francs paid by Pierre Duclos are set aside

said the old men, a great river had flowed richly across their country, bringing with it food and wealth. Then, overnight, the river dried up, as if it had been sucked away. Crops vanished. Ever since, the people had been hungry and poor

The engineers smiled. They knew the legend to be based on truth. Here, long ago, had flowed a branch of the Niger River. Soon after the white men departed, a spate of water 600 feet wide came gushing down the old river bed, while the natives stood on the banks and marveled

The revived flow was an early work of the Niger Valley Authority, launched in French West Africa to exploit the potential of one of the world's great rivers Rising 150 miles inland, the Niger describes a great semicircle, bearing first to the north and then turning southward, to cross into British Nigeria Along its banks lies the gathered fertility of centuries, prime for the growing of any tropical plant.

The aim of the NVA, said Maurice Claude Rossin, chief of social and economic engineering in the Niger River office of the French government,

> is social because designed to regroup a sparse population, to afford them better conditions of life by putting into their hands the means of assuring maximum results from their labor to provide for their education, as it were from the ground up and to encourage their advancement, materially and in things of the spirit
>
> The aim is economic because a country which lived on itself (and lived badly), and which exported nothing is being transformed into a productive region that will exchange products with the rest of West Africa—and the world [3]

Few development schemes can have faced greater obstacles. On other continents technicians may complain that it is difficult to graduate farmers from the use of draft animals to that of machines but in Nigeria the difficulty was to graduate the natives from the use of their own back muscles to that of domesticated beasts

The Nigerian ox is not accustomed to the indignity of labor.

[3] Survey Graph (January 1945)

bles for daily meals; storerooms are full of cereals for the fields
At harvest time each native family first puts aside the amount of cereals
it will need in the year ahead and the amount of seed necessary for
future sowing. The rest is sold by the co-operative for the benefit of its
members. After costs, the remainder represents a net return to each family
on the basis of its contribution to the crop that has been sold.

A Glance at the map of this territory and you will see how readily the
three principal colonies which border the valley—Senegal, French
Guinea, and the Ivory Coast—can be reached. They produce valuable
articles for cash export—peanuts, palm oil, cocoa, coffee. But they need
food. The strategic goal of the Niger River Valley development is to
satisfy just that.

Eventually the NVA will provide not only irrigation but electricity for light industry and refrigeration. Properly used, the wild Niger can raise the living standards of French Nigerians to the level where they can be safely left to continue the task themselves.

BRITISH NIGERIA

Britain's program of African development is centered in two government agencies—the Overseas Food Corporation and the Colonial Development Corporation. It is the Overseas Food Corporation, designed entirely to encourage food production, which has handled the disappointing Tanganyika peanut program. OFC is planting another 50,000 acres to peanuts in Gambia. The Colonial Development Corporation deals with all phases of economic progress in the colonial areas. One of its most interesting projects, also in Gambia, is a program to provide 20,000,000 [illegible] a year. Ten thousand acres of forest are being cleared for [illegible] and cold storage [illegible] meat. Cost of the [illegible] development program which is scheduled

A ten year [illegible] for complete [illegible] (in pounds [illegible] 000,000 and [illegible]

In much of Africa milk and meat are the least precious prod-

He wanders at will in the jungle. To turn him into a draft mal is a slow, painstaking task. But it is not so slow, or so pai taking, as teaching the farmer himself that he can grow . crops if he exchanges his short-handled hoe for an ox and plow. When the teacher has turned his back, the new convert likely to return to the ancestral tool. He is not fully persuade until long example has proven the advantage of the new meth ods.

A second obstacle to rapid accomplishments by the Niger Va ley Authority was World War II. France had little energy spare for colonial experimentation. Nonetheless, work was ca ried on throughout the entire war period. The first great e gineering achievement, the diversion dam at Sansanding, w completed in 1941. The Sansanding dam backs up water 15 miles through canals and once-dry river beds. The canals a navigable throughout the year.

By the time of the surrender of Germany, 50,000 acres previously unproductive and uninhabitable jungle land i French Nigeria had been cleared, cleaned, irrigated, and mad the home of nearly 20,000 men and women imported fro nearby regions of identical climate.

Reports M. Rossin,[4]

harrows, and carts) together with cattle required to pull the farm veh cles, seeds necessary for initial planting, and food adequate to sustain th family until the first harvest. For every unit of 15,000 to 20,000 acres, th colonists are grouped in co-operative agricultural associations . . . po sessing tools of production and processing over and above the requir ments of the individual family—trucks, barges, rice mills, thresher tractors. . . .

Where formerly there were only a few dwellings crowded togethe

ucts of a cow. The most precious is manure for fertilizer. Before Africa can be fully developed, means must be found to fertilize millions of acres of rundown soil.

This problem is particularly urgent in British Nigeria, which with proper treatment may yet become the bread basket of the British Isles. It is not surprising under the circumstances that some Britishers complain about the upstream Niger Valley Authority of the French; it is depriving them, they say, of much of the usefulness of the Niger along the last 1,200 miles of its journey to the sea. To the extent that these complaints are justified, they illustrate the wastefulness of developing river valleys according to nationalistic rather than geographical requirements.

In British Nigeria 1,800 colonial officers rule, through tribal chiefs, more than 10,000 times as many Africans. So primitive are communications that over great areas administrative officers cannot be reached by telegram. Letters are sent by human carriers. Huge tracts are semi-arid; natives walk 10 miles a day for a bucket of water, which they carry home on their heads. Near Awka, fresh gullies 500 feet deep show the quick effects of erosion. Forest dwellers feed on shrubs and giant snails. In parts of the interior, ritual murder is still a native custom. Sleeping sickness, leprosy, malaria, yaws, and venereal diseases are commonplace; most of the people suffer from hookworm, filaria, roundworm or bilharzia (worms in the blood); literacy is below 5 per cent; there is only one hospital bed for every 5,000 persons, as compared with one for 250 in England; tsetse has made it impossible in vast areas to keep any domestic animals except dogs.

But in this land of sickness, ignorance, and abject poverty there are curious contradictory stirrings. Returning from a tour of the African colonies, Aldous Huxley reported the contrast: "Near Enegu, administrative capital of the eastern provinces of Nigeria, I drank palm wine with an old chief, surrounded by his fetiches and jujus, some of them caked with the blood of sacrificial fowls, saw the great village drum, the juju house with its collection of pai [illegible]
men. . . . I . . . [illegible]
twentieth century."

also have every kind of cattle sickness, a great source of loss to the farmer. And we have just scratched away the skin surface of our land. The native tills it for a few years, exhausts its fertility, puts nothing back, and moves on. The result is that the deserts of Africa are gaining ground.

Through Point 4, added General Smuts, the United States can help start Africa toward these basic improvements.

More of Point 4 or its equivalent, and less of peanut plans, appears to be the immediate prescription for Africa. It will be time enough for great expenditures when the land and people have been prepared to take advantage of them.

Europeans are aware with a terrible prescience of the fatefulness of the steps that are now being taken. It is to Africa, after all, that Europe must turn first for markets and raw materials when Marshall Plan funds are no longer available. Washington, by providing expert personnel and permitting use of the Marshall Plan counterpart fund for African development, has indicated its own awareness of the key role which Africa will play in the coming years.

Through Point 4, implemented not only by the United States but by every other free nation with capital and skills to spare, it will be possible to take first steps first without losing sight of the great ultimate goal of a prosperous and productive Africa. Our understanding and support will continue to be essential. Unless Western Europe can turn to Africa and the Middle East for replenishment, the billions we have spent on the Marshall Plan may turn out to have been wasted. If, on the other hand, the natives of Africa can be put to producing richly for themselves and the rest of the world; if they can receive pay for their production in amounts which will turn them into eager purchasers

... comes the world.

immense acreage of irrigable land. The possibilities of this scheme may be gauged when I say that the dam envisaged would hold back the waters of the Zambezi in a lake having a coastline of 400 miles, and impound a quantity in excess of that stored by the great Boulder Dam in the United States. . . . I understand that the hydrographic surveys will take several years to complete, so that I am unable to venture any forecast as to when this source of unlimited cheap power may become available."[5] In Southern Rhodesia, the Sabi Valley will be developed on broad TVA principles, with 100,000 acres coming under irrigation. There will also be exploration of the valley's mineral wealth.

Awesome in its potentialities is the proposal to create a superdam on the headwaters of the Nile—at Owen Falls, near Jinja, Uganda. The Uganda dam would eventually supply East Africa with 22,000,000,000 kilowatt-hours of cheap power—the equivalent of all the hydroelectricity used in the United States as recently as 1925.

[illegible]

creating a balanced economy than a single tremendous mass of concrete. The immediate effects of centralized power production, thrown into a reservoir of cheap labor, may be disastrous.

But in any program as massive as the development of Africa, realities will modify blueprints. Gradually the British, French, and Belgians are coming to realize that in a continent where native populations are frequently 100 per cent diseased, the road to a modern industrial society is a long and tortuous one.

Asked by Mr. Kaltenborn what he would do for Africa if he had $1,000,000,000 to spend, General Smuts, former Prime Minister of the Union of South Africa, mentioned no great dams. Instead he replied:

I'd use it to promote health—human health, animal health, and the health of the land. Africa is full of disease from one end to the other. We

[5] *Colonial Review* (March, 1947).

8

The African Middle East — Gardens for the Sahara

PROCEEDING EASTWARD overland from the Straits of Gilbraltar, keeping the African jungles to your right, you will find yourself after 4,000 miles at the borders of India. Before arriving there you will have traversed a territory roughly twice the size of the United States—the homeland of approximately 200,000,000 of the world's 225,000,000 Mohammedans. Here, in the Near and Middle East,[1] civilization was born. Some students believe that here, too, civilization may receive its death blow.

In the Middle East the Babylonians, Assyrians, Egyptians, Medes, and Persians flourished. Across the Middle East the Greeks, Romans, Mongols strode on their imperial conquests. In the Middle East the Ottoman Empire sprang to martial life.

In the [illegible]
racked by r[illegible]
grovel like [illegible]
at twenty-five. They are too often subjects of degenerate and corrupt rulers; they are generally illiterate; they are frequently stupid from sickness, undernourishment, and filth. Where the ruins of vast public buildings may still be discerned on the sites of ancient cities, there now squat wretched villages. Where there were once dams and aqueducts, the goat herds of nomads pick at the scanty vegetation.

Yet this is the crossroads of empire, the heartland of the world.

It is strange for an American to reflect that the power, the prestige, and even the continued peace of his country may de-

[1] The borders of the Middle East depend largely on the whim of the cartographer. [illegible]

grave problems. This area contains vast natural resources. It lies across the most convenient routes of land, air, and water communications. It is consequently an area of great economic and strategic importance, the nations of which are not strong enough . . . to withstand powerful aggression. It is easy to see, therefore, how the Near East and the Middle East might become an area of intense rivalry between outside powers, and how such rivalry might suddenly erupt into conflict.

The President proposed two preventives. First, he said, there must be no interference, by force or penetration, with Middle Eastern sovereignties. Second, the countries must be aided to develop their resources and raise their standards of living.

At the time of this address, political analysts still assumed that most of Mr. Truman's policy declarations, frequently improvised and obviously phrased with an eye to their political effect, might safely be forgotten as soon as they were uttered. They have since learned better. Few men in American public life have hewn so closely, and sometimes so exasperatingly, to their statements of intent. If the political analysts in 1946 had paused a little more thoughtfully over the paragraphs just quoted, they would have been less surprised at the Truman Doctrine in 1947 and the Bold New Program in 1949. Just as Latin America provided the experience which proved the feasibility of extending technical and financial aid to underdeveloped areas, so the Middle East provided the political necessity which forced the program from the realm of dinner chatter to the test of practical action.

Other more pressing problems took precedence for the United States over the economic and social development of backward areas. The administration had to deal with military aid for Greece and Turkey, with economic recovery for Western Europe, with the North Atlantic Pact. Only when this essential groundwork had been laid did it become possible to turn thoughtful attention to the key problem of our generation—the unredeemed misery of two-thirds of the people in a world which possessed all the technical facilities for making human welfare universal.

To be sure, the British under the Labor government had drawn up a master plan for vitalizing the economy of the Middle East [illegible]

Meanwhile the Jewish homeland in Palestine had become [illegible] manthus, and Sarpedon, it appeared that the seed now planted in Palestine might yet result in new order, justice, and vitality for the followers of the Prophet. If the outbreak of war between Jew and Arab was a terrifying reminder that the Middle East today is more than ever a danger spot, cessation of the conflict provided an uneasy breathing space by which the Middle East might profit to seek stability, prosperity, and permanent peace.

In Washington, the alternatives were bluntly phrased. Israel could be either a stimulus to the economic and social betterment of the Arab nations [illegible] inaugural address, therefore, was to hold out hope that if peace could be maintained the United States would provide technical and financial aid to both Jew and Arab.

The technical aid will come first. The immediate needs of the Middle East are for minimum standards of health, education, transportation, agriculture, light industry, and political administration

When a tiny experiment station operated by the Near East Foundation in Lebanon identified in 1948 the pest that had been ravaging the vital tomato crop in the Bekaa valley, the successful experiment not only saved thousands of dollars and tons of precious food—it also mapped the kind of road that Point 4 seeks to follow.

When the World Health Organization stopped an Egyptian cholera epidemic in its tracks in 1947, it was mapping the same kind of road. The cholera epidemic while it lasted disorganized

the economic life of all lower Egypt. It threatened all Europe. Yet WHO whipped it in less than six weeks' time!

It was in Egypt, too, that the anopheles gambiae mosquito started in 1942 a malaria invasion even more dreadful than the one that had devastated 12,000 square miles of Brazil a few years before. In some parts of upper Egypt malaria struck down 90 per cent of the population. An average of more than seven-tenths of the people in Nile villages were infected. Within two years the death toll reached 135,000.

The Egyptian government in 1944 called on the Rockefeller Foundation for help. By 1945 the gambiae in Egypt were a thing of the past, wiped out by drainage and spray guns. Today there is no malaria in Egypt.

Without malaria, Egypt is more nearly ready for improved farm practices, industrialization, and a richer life than is, say, Iran, where 82 per cent of the farmers still suffer from malaria, where peasants live in shacks without windows, wear clothing consisting of old rags, and believe that raising chickens may call down a divine curse, or that planting vegetables may destroy fertility.

[illegible]

waterways, trade stagnates—and so do nations.

Commented David L. Cohn in the *Atlantic Monthly*,[2]

> Without [transportation], there may be a surplus of food in one place and a famine in another; a hunger for goods on the one hand and surplus on the other. Moreover, costs of transportation by coolie's back, cart, or camel are inordinately high, no matter how low the coolie's wages or the camel's upkeep. It is unnecessary to stress the point that we must develop transportation services in the East as a primary condition to the prosperity of the region.

[illegible]

[2] July, 1946.

where the king owns a fifth of all the fertile land and 17,000,000 of his 20,000,000 subjects own not a square foot, and where a fellah who is very lucky may earn $25 a year.

MOROCCO

Large-scale planning is no novelty to North Africa. Maurice E. H. Rotival, now in charge of planning for the French in Madagascar, recalls that "One of the greatest development plans ever done as a whole and financed by both government and private groups was the development of Morocco, which started during the First World War and arrived at full development around 1930. The speed with which that protectorate was developed, with very little mechanical means at our disposal at the time, appears to me today fantastic. In less than twenty years that country, which is as large as the state of Texas, was completely electrified with hydroelectric and steam plants, and railroads were electrified too. The country was covered with roads, harbors were built of stone, and beautiful modern cities like Casablanca, Fez, and Marrakech were built according to plan, protecting very carefully the old Islam cities which were separated from the European parts of the cities by grants, pacts, or spans of land. . . ."

But the planning of the 1920's is inadequate by the standards of the 1950's. Between 1936 and 1947 the population of Morocco grew more than 40 per cent—from 6,300,000 to 8,900,000. To provide food for these new mouths, the French launched a ten-year plan aimed at adding 500,000 acres to the farmland by irrigation and another 315,000 acres by drainage. Farm mechanization—already extensive—is being expanded to raise the production of cereals to a point above the needs of the population. The French are also sextupling the supply of electricity (from 100,000,000 to 600,000,000 kilowatt-hours annually) and are using the power to bring light industries to Morocco. Private investment from France and abroad is pushing up Moroccan canneries, cement plants, flour mills, and sugar refineries. In Algeria it is developing phosphate, manganese,

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scheme in the world, surpassing any even in the United States or Russia.

A dam on each of the two rivers, said Mr. McNeil, will provide Uganda, Ethiopia, and Egypt with "very substantial" electric power, and the vast area of the Sudan will become "at least a great ranching country and, at the best, a country of well-balanced agriculture." The tremendous Owen Falls Dam across the Victoria Nile in Uganda[a] will control the level of Lake Victoria and produce enough electricity to power all the industries Africa can establish in a generation.

Egypt, Ethiopia, Uganda, Belgium, and the Sudan will share in costs of the project. Its completion is expected to take nearly a quarter of a century.

THE QATTARA DEPRESSION

Incalculable as the significance of the Nile River dams may be, for dramatic color they are excelled by two other schemes which have been blueprinted for northern Africa.

First of these is the proposal to inundate the Qattara depression, a great natural hollow, virtually uninhabited, which was discovered in modern times in the northern part of the Libyan desert, not far west of Cairo. The depression lies well below sea level. By admitting sea water from the Mediterranean, 35 miles away, the influx being balanced by evaporation from the surface of the salt lake which would thus be formed, it has been estimated that it will be possible to obtain a reliable net output of power ranging from 150,000 to 200,000 kilowatts—up to 1,000,000,000 kilowatt-hours a year—depending on the level of the lake and, consequently, the distance that the incoming water will have to drop.

The estimates assume a doubling of rainfall as the result of creating an artificial lake containing 19,500 square kilometers. Doubling the rainfall will mean also the growth of vegetation on the shores of Qattara Lake, settlements, and commerce and

[a] See Chapter VII.

of this vast body of water would lie 10,000 square miles of newly cultivable territory. Not only would the Braman Sea promote rainfall, thus providing its shore areas with water for crops, but it would create an avenue of commerce for the cities that he predicted would spring up there. The dikes in the hills would enable trees to be planted where no vegetation has grown for two thousand years.

The boldness of the Braman concept can be compared only with that of Ferdinand de Lesseps in opening up the Suez Canal. Commented the *London Morning Post:*

> A barren and uninhabitable region would be converted into a land flowing with milk and honey, sheep and oxen, and inhabited by a prosperous population. . . .
>
> The prospect of supplying Europe with a new granary is certainly an attractive one; and it is not surprising to hear that such a scheme put forward by so serious and responsible an undertaker should be under the consideration of the French government. Algeria, Tunis, and Morocco would all be affected immediately, and apparently to their great economic benefit; but those who accepted responsibility for such an experiment would be bound to satisfy themselves that all the consequences had been measured. So audacious an interference with physiography might well raise misgivings in timid minds. Does not the Prophet Amos declare that "who calleth forth the waters of the sea, and poureth them out upon the face of the earth, the Lord is His name"? And it is impossible not to reflect that it might be easier to do this thing than to undo it. On the other hand, some of man's greatest triumphs have been in the direction of modifying his environment to his needs and of reclaiming waste spaces to his use.
>
> Nor is it in the tradition of the French any more than of the British or the American genius, to shrink from great engineering enterprises. But what would be the effect, not only in North Africa, but on Southern Europe? Neither the engineers, nor the physiographers, nor the economists can answer that question confidently.

Many years will pass before the energies of man can be spared from more immediate problems to make the Sahara Desert bloom again. Long before, there must be the soap and the [illegible] improved seed and the processed goods, the trained

States stands ready to lend a firm and helping hand in such an endeavor.

But even assuming such co-operation, there is little agreement as to the most practical immediate steps toward improving Middle Eastern economy. Many of the countries have prepared ambitious nationwide programs such as the $650,000,000 overall development scheme in Iran and the great Jordan Valley Authority blueprint in Palestine. Aiding and abetting this massive thinking are American engineering firms which sometimes seem to visualize development purely in terms of dam installations and steel factories.

It is not surprising that many Middle Eastern nations should think of Point 4 as a device for financing and supervising pet national projects. And it is not unlikely that they will be deeply disappointed to discover that Point 4 proposes no financing of such projects outside the banking institutions already in existence. Capital investment from private sources will not flow reliably until the underdeveloped areas have proved their readiness for it in terms of both ability and stability. Investments made in advance of such a demonstration will lose a great part of their theoretical effectiveness at the best; and at the worst they may actually set back common-sense development by many years.

IRAN

A striking example of a project which, in the wrong hands, [illegible] grass roots [illegible] ounced in the fall of 1949 a seven-year development program which aims at increasing the agricultural and industrial output of Iran more than 200 per cent. Participants in Overseas Consultants include some of the most famous engineering concerns in the United States. Their program is to be financed from internal Iranian loans and annual oil royalties of more than $50,000,000.

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A striking example of a project which, in the wrong hands, could specialize in the grandiose at the expense of the grass roots may be found in Iran.

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Freedom of thought, of expression, and of action are also related to economic development. . . . How fear of authority still operates in Iran the Near East Foundation learned last year. Its agents gave some cash loans and a few cows to some peasants in Varamin, a district twenty-five miles south of Teheran. The next day the peasants returned the money and the cows, saying they could not keep them. They feared to incur the displeasure of the village headman (kad khodā) and the cowman (gavabānd) who rented cows to them.

Ala'i concludes that "the most precious export commodity the U.S. has to offer is not its money wealth, but its revolutionary society in which individuals take their chances, express opposition to authority when and if they want to, and feel no dread of punishment if their experiments fail; can they not try again or do something else? The basic requirement of all growth is the opportunity for the citizen to try new ways of production, new methods of doing business, and new means of improving his lot in life."

He might have added another characteristic of private-enterprise as contrasted to public-enterprise developments: private enterprise measures a going operation not by its aims but by its results—and the sooner it produces results the better. Results mean profits. Often, therefore, business organizations accomplish in months or years what would take decades for government working alone.

Fortunately for the ultimate usefulness of the Iranian seven-year program, its American director, Max Thornburg, has long emphasized the folly of substituting great government expenditures for basic local improvements. Under his leadership it may be hoped that the program will move first in such imperatives as men, land, water, and roads, letting derivatives—steel mills and locomotive factories—wait for a riper time. Carried on in immediately modest terms, the Iranian development may become a working model for Point 4 in the Middle East.

In turn, a working model for Mr. Thornburg may be the experiments carried on near Teheran by the Near East Foundation.

The Near East Foundation shortly after the close of World

in Turkey by the extension of her railway system to link it with those of Iran and Iraq. This and other Turkish modernization programs are concentrated in government hands.

Ambitious, modern plants have been established to fill needs which do not yet exist, while small factories to make soap or steel-tipped plows are lacking. Until the hiatus between modern factories and wooden-stick plowing can be bridged, there is little likelihood of a healthy economic program.

Thornburg argues that American investment cannot flow effectively, if at all, into Turkey until that country demonstrates by actions that it has abandoned former restrictions on outside capital, including all the bewildering apparatus of contradictory

thousands of Turks in management, engineering, and agricultural skills.

Start, Thornburg begs the Turks, on a small scale. Don't try to calculate how much capacity you would need to make pitchforks or wagons for all Turkey; set up just one plant, and try it out. Don't break your backs on a mill to produce 500,000 tons of unnecessary steel; set up just one 50-ton jobbing iron foundry on the basis of existing demand.

But first of all, bring in experts—experts in government; in public works; in housing, chemistry, mining, geology; in agriculture, public health, education, economics. Let them multiply

bor modernization, increase production for export. Before creating elaborate new irrigation facilities, put to work the ones that are already three-quarters completed and for years have stood idle.

Turkey's Electrical Energy Institute has drawn up plans to construct thermal plants which within the next five years would multiply her annual electric power six and a half times, at a

delivering 300,000 barrels of oil daily to the Mediterranean, Aramco is laying 1,100 miles of roads, and the government is building 1,200 miles more.

Point 4 itself will launch its Arabian program on no such large-scale basis. Instead, the program in its first stages will consist primarily of elementary steps such as probing for underground water.

The great need of Arabia is water. Ancient, disintegrated catchments near Al Taif indicate that in bygone days Arabia had fertile, irrigated fields. The idea of restoring this fertility has fascinated many Americans, including the late Franklin D. Roosevelt. In Frances Perkins' book, *The Roosevelt I Knew*,[4] she recalls the President's conversation with an Army engineer as he was being flown over the meager vegetation of Saudi-Arabia on his way home from Yalta:

> "*Why don't they raise something here? Is the soil absolutely infertile?*"
> "No," *answered the engineer,* "*it is good soil and could be used if there were any water at all.*"
> "Can't they irrigate?" *asked the President.*
> "They can't irrigate because there isn't any water here to irrigate with."
> "But," said the President, "there must be some water here. The people must drink and the animals must be watered."
> "Yes, there are wells and here and there is an oasis, but water, as you know, is sold at a high price."
> "Well," he said, "how do they get the wells? Dig them?"
> "That is the answer."
> "How far below the surface is the water table?"
> "About 50 feet."
> "Is there real water there?"
> "Yes, I think there is plenty of water 50 feet below the surface."
> "Well, the solution seems to be to bring out some good pumps to [illegible]
> the soil."

[4] (New York: the Viking Press, 1946).

industries. Work on the roads started in 1947, and 200 American engineers are completing them now with native assistance.

One road, running 65 miles north and south along the old British army route, links Kandahar with Spinbaldak at the Pakistan border. On the new highway Afghan trucks can speed their melons and grapes to market, taking only three hours instead of twelve for the trip and making it possible to double or triple fruit exports. The second road, 75 miles long, leads southwest to Girishk.

Morrison-Knudsen is training local men as technicians and machinists so that once the construction work is finished the Afghans can themselves maintain roads, machinery, and irrigatio [illegible] Afghanistan. Means are [illegible] fled technical schools there, and of bringing [illegible] ls to the United States.

But in Afghanistan, as in Iran, there is danger that the superstructure may be built before the foundation is laid. The Point 4 program for Afghanistan calls immediately for only the simplest reforms. Most Afghan homes, for instance, are made of mud-covered slats. The mud is constantly drying and flaking away. Squalor could be reduced and health improved if the Afghans were taught to make bricks of tamped earth. Again, the Afghan educational problem is not primarily one of finding school buildings—there are buildings in adequate quantities. But there is no reserve of teachers. Until there is such a reserve, there can be no modern school system in Afghanistan; and until there is a modern school system, the Afghans can scarcely be expected to assume responsibility for carrying on their own economic development program.

SYRIA

The danger of industrialization without a solid economic base has been vividly demonstrated in the recent experience of Syria. During the war Syrian capitalists built textile and glass mills.

But the Syrians had no money to buy the textiles and the glass, nor could markets be found in neighboring Arab countries. The result was an intensification of the ever-present Middle Eastern poverty, clamor for amalgamation with Iraq, and three military coups in less than a year's time.

The United Nations has proposed a fresh approach to the problem of Syria—a pilot project of drainage and irrigation which would add 175,000 acres to the country's crop land, covering the $13,000,000 cost through a 100 per cent increase in land values. If the initial program works, larger ones will follow.

PALESTINE

Three thousand years ago Palestine was the Promised Land. Here, the Lord told Moses, was "a good land, a land of fountains and depths that spring out of valleys, a land of olive oil and honey, a land wherein thou shalt eat bread without scarce- [illegible] though production increased by more than 20 per cent between the middle of 1948 and the end of 1949.

Prior to World War I there were perhaps 60,000 Jews in Palestine. At the outbreak of World War II there were 500,000. Today there are more than *twice as many*. These men and women "drained swamps; constructed roads; built agricultural settlements, towns and cities; established schools and universities; dotted the land with hospitals, clinics and health centers; founded industrial and financial enterprises; harnessed the Jordan for electrical power; made of the Dead Sea a source of potash and bromine. They invested in Palestine about $500,000,000, and made of that desolate, neglected province of the Turkish Empire an outpost of Western civilization and of European trade."[8]

[8] Eliahu Ben Horin, *The Middle East, Crossroads of History* (New York: W. W. Norton, 1943).

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Morrison-Knudsen is training local men as technicians and machinists so that once the construction work is finished the Afghans can themselves maintain roads, machinery, and irrigation canals.

Coincidentally, American teachers are going to Afghanistan. Means are being sought of organizing American-staffed technical schools there, and of bringing Afghan pupils to the United States.

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exchange for their present holdings. Iraq would be the gainer, for it badly needs agricultural population.

Today millions of people are being moved from one land to another. If the lands were organized and homes provided, this particular movement could be made the model migration of history. It would be a solution by engineering instead of by conflict.

The political realities of the moment unfortunately made it impossible for the Arabs to consider giving up their demand for sovereignty over Palestine, much less deserting it completely. Since 1945, however, a war has taken place. At least 700,000 Arabs have fled from Israel. The Israelis show small eagerness to have them back. The displaced Arabs are living in caves, in tents, in hovels, eking out the relief money granted them by the United Nations. By comparison, model farms in Iraq would be Paradise.

Two hundred fifty thousand Jews of Iraq, Syria, Lebanon, Egypt, and Yemen meanwhile might well be
move to
and Turk
to the we
successful excision of an ancient sore. Now, if ever, would seem to be the psychological moment for a much less difficult exchange of populations in the interests of Middle Eastern stability.

Whether the Iraquis would welcome immigrating Arabs is another question. "We do not want immigration," said a high Iraqui official recently, "even of outside
'born' our

will be proposed
the West, and the
accept will be very strong. One of those inducements—the eventual re-creation of a nation of 30,000,000 where now less than 4,000,000 drag out weary lives—will be hard to resist when its potentialities are fully realized.

Despite bitterness engendered by the Palestine war, the Middle East still looks upon the United States as being the nearest thing they have to a disinterested friend.

Disinterestedness is not, to be sure, the altogether accurate word. A prosperous Middle East, like a prosperous Latin America or Africa, means a profitable market for the United States as well as Europe.

But quite apart from its possible market value, the Middle East today presents us with an opportunity of historic proportions. It is an essential area to us and the world—militarily, economically, and socially. Under the Bold New Program Americans can help to establish more Middle Eastern schools, exchange more teachers and students, forward more technical advisers, medical missions, books. Investments, factories—and peace—may follow.

If the opportunity is grasped, we can create the preconditions now for stability in the Middle East. And stability in the Middle East is a long step toward stability everywhere.

10

Asia Must Be Saved by the Asiatics: *a. Southeastern Asia*

ON THE basis of the postwar record to date, there is little reason to think that the Far Eastern mainland will be saved from Communism. At least there is little reason to think it will be saved by the United States.

The fact remains, however, that the Reds could not have overrun China so casually if the masses of Chinese had opposed them as tenaciously as they once opposed the Japanese.

your own high standard of living, my people will simply say to hell with you and turn to someone else."

The Pakistan Finance Minister added that the United States overestimates her ability to bolster any nation with American military production. A far surer way to halt the advance of internal Communism, he maintained, is to do something else that no Asiatic government can accomplish unaided—"to make two grains grow where one grew before."

If that were indeed all that was needed, the answer might be at hand. Techniques exist for vastly increasing the food production of the Orient. Many are already being put to work.

Take, for instance, the matter of rinderpest.

the water buffalo to till their ancient fields.

But a contest of wits during World War II ended the invincibility of rinderpest. British Secret Service men discovered that the Germans were planning to import the dread disease into the United States. In co-operation with the United States government, a highly secret laboratory was established on an island of the Saint Lawrence River. Here experiment after experiment finally resulted in a rinderpest vaccine of virtually 100 per cent effectiveness

In 1948 the Food and Agriculture Organization, working with the Chinese Nationalist government, developed a way to produce the vaccine inexpensively in enormous quantities. Be-

the scourge of rinderpest throughout the entire world in ten years.

Then there is rice—the basic food of more than half the

raised 50 or 100 per cent by irrigation alone, while manures could add 20 or 30 per cent more. Ninety million acres—26 per cent of India's total cultivable area—still lie unused.

The willingness of Asiatics to profit by modern methods of farming has been illustrated by the experience of such schools as the Missionary Allahabad Agricultural Institute in north central India. The Institute developed steel plows to double the width of the Indian furrow—and the natives immediately began clamoring for them. It cross-bred cattle until milk production rose by a third—and the Indians carried on the work with their own cows.

But these simple, quick, and relatively inexpensive programs can do only part of the job of increasing the food supply of the Far East.

Pre-eminently there must be land reform, plots must be big enough to make efficient farming feasible. There must be changed fertilizer practices—which can be had only when artificial fertilizer is available at a price that the farmers can afford to pay. There must be more water for irrigation. Some day there must be mechanized farms. All these changes will take a long while—and most of them cost a lot of money.

The average farmer of Southeast Asia has less than 5 acres of land at his disposal, in contrast to 145 acres per farm in the United States. Frequently the holdings are broken into a number of isolated strips. Land reform and co-operatives to make the peasant an efficient producing agent were a rallying cry of the Communists in China. Land reform and co-operatives in the other countries of the Far East are essential if the fate of China is not to be theirs also.

And if land reform is essential, improved fertilizer practices are scarcely less so.

It may be true, as Sir Albert Howard says, that "the agricultural practices of the Orient have passed the supreme test—they are almost as permanent as those of the primeval forest, of the prairie, or of the ocean. The smallholdings of China, for ex-

Siamese are at work on the Chao Phya program—14 separate irrigation projects affecting 5,000,000 acres of land.

Greatest of the schemes which have any immediate prospect of execution lies in India, where the government seeks to increase food production not simply by the 2,300,000 tons of food grain a year needed for a passable diet, but by 10,000,000 tons.

India's plan envisages dams and barrages on most of her major rivers—rivers with strangely beautiful names like Kosi, Tista, Godavari, Tunga Bhadra, Dhirangarh, Chambal, Damodar, Kethar, Bhakra, Lam. The dams will control floods, conserve soil, irrigate more than 5,000,000 acres. They will also increase India's electric power by 26,000,000,000 kilowatt hours a year—four times her present production—raising her potentially to the first rank of industrial nations.

Norris E. Dodd has estimated the world deficit in foodstuffs to be not higher than about 10 per cent of present world requirements. As far as the Orient is concerned it appears possible to agree with his statement that "his deficit ... could easily be turned into relative abundance, even in the face of population trends."

But there may not be time to set Malaya, Burma, Ceylon, French Indo-China, Thailand on the road to modern farming—unless we [illegible] the time by ourselves setting up a military wall between [illegible] and the dynamic Reds of China.

For this reason some influential persons in Washington have recommended [illegible] of concentrating our aid on India and Pakistan. These two governments are powerful enough, they contend, and the Communist [illegible] there is still weak enough, so that revolution [illegible] can be held at bay while economic reform is going on.

But even [illegible] the Chinese Communists will be years digesting [illegible] and that meanwhile the remainder of Asia will have [illegible] thing [illegible] land reform and increased food will not at the [illegible] to raise the Oriental standard of [illegible] for more than fleeting moments.

[illegible] river valley projects in India, see [illegible]

tise can be reconciled with the aims and expectations placed before and entertained by the mass of the people.'[4]

One of the most vital services that American capital can perform is to act as guide, philosopher, and friend to Asiatic business. Most American businessmen have learned—some of them the hard way—that in the long run the most profitable enterprise is the one which renders the best treatment to its own workers and the greatest service to its customers. It may be doubted whether Indian industrialists—a small and extremely conservative group of men—have yet absorbed this lesson. As industrialization proceeds, American capital in Asia can do much to preserve competition, prevent cartelization, and help assure a rising standard of living.

When private capital last year was loaned to India to rehabilitate and expand her railway facilities, that capital was not only relieving distress but promoting industrial development. As the *New York Times* commented: "There is nothing of the 'global do-gooder' in the idea of making a sound loan for an obviously practical purpose. . . . It is Point 4 in action."

In many instances, however, the time for private capital investment has not yet arrived. The Bold New Program has first to create the conditions of health, agricultural efficiency, and technical skills which can make investments attractive.

One of the first major projects envisioned for Point 4 is a pilot plant in the Far East to show how hydroelectric development can be combined with sensible soil conservation and later with industrial development. The planning of such a plant may be completed in 1950, and the plant itself the following year. Thereafter similar pilot plants could be established in other parts of the world at a starting rate of about one a year.

I repeat once more that in the last analysis the West can furnish only the pilot plants—the underdeveloped areas will have to produce the rest.

We cannot save Asia from Communism. But, with our help, the Asiatics may save themselves.

4 D. R. Gadgil, "The Economic Prospect for India," *Pacific Affairs* (June, 1949).

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[5] D. R. [illegible], "The Economic Prospect for India," *Pacific Affairs* (June, 1949).

The largest public work yet introduced into Australia is the Snowy River project, which will double the Dominion's production of electric energy.

Flowing southeast from the Australian Alps of New South Wales, the Snowy River now empties uselessly into the Tasman Sea. Under a program laid down last year, 100 miles of tunnels driven through the Alps will divert virtually all the Snowy's headwaters—nearly half its total volume—into the nearby Murrumbidgee and Murray Rivers. The dropping water will pass through 16 underground power stations with the enormous generating capacity of 1,720,000 kilowatts. Seven dams will back up 1,800,000 acre-feet of water for irrigation.

The Snowy River project will cost between $550,000,000 and $640,000,000. Eight years will pass before the first water is available for irrigation, and perhaps twenty-five years before the plan is completed.

The scheme was initially approved as a defense measure, and the underground power stations will be scattered strategically through difficult mountain country. The peacetime possibilities of the project, however, are no less important. Says a *New York Times* dispatch

> Power not required for defense purposes in peacetime would be distributed through the power grids of New South Wales and Victoria for industrial use and the irrigation authorities of the two states would use the water for increased food production. The power would be delivered to Melbourne and Sydney at about half the cost of that now generated by stations burning coal or oil. If the power is to be used for new industries, established in inland towns near the source of supply, the cost may be little more than a third of the present cost of power in Melbourne and Sydney.
>
> The potential power output of the project represents the consumption of 4,000,000 tons of coal a year, about one third of Australia's present output, or of 547,000,000 gallons of oil a year. Australia imports all her oil. The saving that would be entailed by generating electrical output by water instead of coal is estimated to be almost $22,400,000 a year.

On the islands between Australia and Japan, an industrialized

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but Japan is only an offshore extension of Asia. If Asia is saved, Japan is saved also. If Asia is lost, there is no way for a free Japan to survive. "Basic solutions for Japan," comments Jerome B. Cohen, "can come only with the complete integration of its economy with those of other Far Eastern countries. Efforts in Japan alone are bound to be unsuccessful."[1] And G. B. Sanson, International Research Chairman of the Institute of Pacific Relations, adds: "It may be that hungry, ill-clothed and worried men in some countries will pour their energies into a struggle for political freedom; but it is extremely doubtful whether Japan is one of those countries."[2]

Granted an integrated economic program and a stable East Asia, Japan might export enough goods to pay for the imports which she must have to maintain herself on a reasonable living level. The Japanese Economic Stabilization Board estimates that for a self-supporting economy by 1953 Japan must multiply the 1947 level of her exports nine times and that of her imports three times. She must have credits from the United States of $2,000,000,000; she must put a stop to inflation; she must solve her deficiencies in power supply and transportation.

Though Japan is a highly industrialized nation by Asiatic standards, by American standards she is just getting started. At the end of 1949, for example, she had 1½ telephones to 100 persons; America had more than 1 telephone to every 3 persons. The Stabilization Board estimated that this one lack was costing Japanese business more than $100,000,000 a year. In many offices, it calculated, a single telephone could replace two employees.

Though all Japan's goals for 1953 are extraordinarily difficult, the record indicates that none is impossible. Between 1930

1 *Japan's Economy in War and Reconstruction* (Minneapolis, University of Minnesota Press, 1949).
2 Ibid.

What about China, now that the Communists own her?

After the First World War, Dr. Sun Yat-sen, founder of the Chinese Republic, outlined a program for harnessing the dragon. He proposed introduction of modern agriculture, communication, transportation, and industries. His proposals staggered men's minds: the creation of three great ports and many smaller ones, the construction of public utilities and of modern cities at all transportation centers, the development of water power, iron and steel works and cement plants. Elements of the program were mineral and agricultural development, reforestation, tremendous irrigation complexes, great new canals, thousands of miles of telegraph and telephone lines and radio stations.

Until recently, the Chinese believed that with American help they might achieve most of the Sun Yat-sen goals in a twenty-year push According to Theodore H. White, it was hoped to create over that period 100,000 miles of railway—half to be double-tracked—which would utilize 25,000 locomotives, 300,000 freight cars, 30,000 passenger cars. Half a million new autos would be introduced each year for ten years; 1,000,000 miles of highway would be laid down; power plants with a 20,000,000-kilowatt capacity would be erected; 80,000,000 telephones would be installed; 1,000,000 homes a year would be built There would be 10,000,000 tons of ocean-going shipping, 320,000 cotton looms, 16,000 woolen looms, 94,000 silk looms

But the postwar years did not develop as the planners had expected And at last the Communists of China cut off the only aid which could possibly bring them to a fully industrialized China in the foreseeable future—aid from the United States.

For fifty years, the American people have been the nearest thing the Chinese have known to reliable friends. An independent China, uncontrolled by any power, has always been to our interest. We have stood for that principle at times against a line-up of all the other major powers of the world. The United States in coming years will continue to promote Chinese independence

. . Nitrogen, they declare, can pay the entire cost of the
·e project within fifteen years of its completion, while
·g 50 per cent of its power potential still available for
s own industrial development.

·reliminary development proposal was put forward dur-
·e war by Alex Taub, then Chief Engineer of our Foreign
·mic Administration. At his request, American concerns
·ied detailed specifications of what it would cost to set up
·omically feasible units of their industries in China. The
·rint called for 625 factories and 260 thermal power-pro-
·ng plants, most of the latter to be erected on sites selected
later hydroelectric developments. Wh . . .

. . . . .nd produc-
. . . China's reserves are the fourth largest in the world
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. . . . of Shang-
. . . experienced industrialization—industrializa-
·n with social effects markedly similar to those in British and
·merican factory towns a hundred years and more ago. Prewar
. . ghai has been cited by M . . . . . e example
. . . . at agricul-
. . . . ters's." Mr.
. . . . .

Modern machinery was brought into a reservoir of cheap labor. Prod-
·cts were then manufactured at low cost but sold primarily on a foreign
·arket yielding foreign credits. Shanghai did not buy the major portion
·f its food supply from Chinese farmers. Shanghai bought most of its
·heat, not from Chinese farmers, but in foreign markets. The same was
·rue of rice to a somewhat lesser extent. Chinese farmers, on the other

and unity. It is conceivable that as the Chinese people gradually realize how heavy a price Moscow asks for her benevolence, they will again appreciate the quality of ours.

If ever the day should arrive when it is again feasible for the United States to extend aid to China, the blueprints are ready.

Dam projects awaiting execution in China can increase her electric production fifteenfold within a score of years.[3] The increase would amount to 115,000,000,000 kilowatt-hours annually—about as much as was used in 1936 by France, Germany, Russia, and the United Kingdom combined. To match the energy latent in the rivers of China would require more than 1,000,000,000 strong men laboring eight hours a day, six days a week.

Huge dams will rise some day on the Yangtze, the Te-Tu-Ho and Ma-Pien-Ho, the upper Ming-Kiang and Kwan-Hsien, the Tang-Lang-Chuan, the Lung-Chi-Ho, the upper reaches of the Yellow River.

Most far-reaching of the projected developments—and farthest in the future—is that on the Yangtze River, 600 miles from Shanghai. This scheme, unique in engineering history, will eventually irrigate 10,000,000 acres, check the floods that have ravaged China for centuries, and enable ocean-going ships to sail inland to Chungking. Costing $1,000,000,000, it will have hydroelectric installations with a generating capacity of 10,560,000 kilowatts and a production of more than 81,000,000,000 kilowatt-hours a year. It will make possible metallurgical industries, electrified railroads, and vast quantities of nitrogen for China's depleted soil.

John Savage, American designer of Grand Coulee, Hoover, Bonneville and many of the East Indian dams named in preceding pages, considers the Yangtze project the climax of his engineering career. Savage and his backers contend that nitrogen fertilizer can be furnished by the Yangtze development in such abundance that not only will China's soil be enriched, but 100,000,000 sterile acres in the United States can be revivified by nitrates selling at half the delivered price of present nitrog

[3] Major hydroelectric schemes contemplated for China are listed in the appe

imports. Nitrogen, they declare, can pay the entire cost of the Yangtze project within fifteen years of its completion, while leaving 50 per cent of its power potential still available for China's own industrial development.

supplied detailed specifications of what it would cost to set up *economically feasible* units of their industries in China. The blueprint called for 625 factories and 260 thermal power-producing plants, most of the latter to be erected on sites selected for later hydroelectric developments. When the dams were ready, the thermal units would be used as auxiliaries or removed to other locations. The program was to begin with the production of coal—China's reserves are the fourth largest in the world—and of steel. Next step was to be power alcohol refineries to offset China's lack of oil. In recognition of the transportation problem, a key part of the Taub scheme was a simple engine mounted on an iron framework and four wheels. One of the basic ideas was to export American know-how, so that after an initial period of technical tutelage the Chinese might go ahead on their own.

But industrialization must be a *social force*, acting for the benefit of the many as well as the few. The city ports of Shanghai have already experienced industrialization—industrialization with social effects markedly similar to those in British and American factory towns a hundred years and more ago. Prewar Shanghai has been cited by Morris Cooke as "a prime example of a distant industrialized people exploiting a distant agricultural people for the former's advantage, not the latter's." Mr. Cooke continued:

wheat, not from Chinese farmers, but in foreign markets. The same was true of rice to a somewhat lesser extent. Chinese farmers, on the other

dams, harbor facilities, dikes, terraces, air fields. And they may do so without greatly reducing agricultural output, if at the same time they apply improved techniques to the farms. It would be stupid, therefore, to take for granted that China will make no economic improvement under the Communist regime.

"We of the West," comments one economist,[4] "must not overemphasize the irreplaceability of machinery. Innumerable processes which would be fantastically expensive in the United States, if carried out by hand labor alone, may be done most economically in a country like China with no mechanical help at all. The bulk of Chinese freight is, and probably will for

hopeless. It is perfectly possible for those countries too to draw on their great reservoirs of cheap man power to create roads and dams, if they possess the necessary energy and determination. To be sure, in a free society workers must be treated and recompensed as free men; they cannot, as in a Russia or a China, be forced to work whether they want to or not. But in the long run a free man working for a decent wage is bound to outproduce a slave. And in free Asia's mobilized resources of man power she can add a key element of which the Chinese have wilfully deprived themselves—the machines, capital, skills, and democratic flexibility of the western world.

In counting the assets which, properly used, can raise the living levels of mankind, it is as well not to forget that men themselves, even if they work with hands instead of bulldozers, are the greatest asset of all.

[4] Warren Wilhelm, *Soviet Central Asia: Development of a Backward Area*, Foreign Policy Reports, February 1, 1950.

piling basic raw materials. But to whip that shortage, Europe must produce more food and goods at lower costs; and she must consume at home a greater part of what she produces.

But for mass production and lowered costs there must be a mass market; and the European market is whittled at—nay, chopped to mincemeat—by cartels, by juggled currencies, by tariffs.

Despite the valiant efforts of Paul Hoffman of ECA, competition between Western European states for the limited dollar markets continues at fever pitch. Despite devaluation of the British pound, British dollar reserves are still in grave danger. Despite gestures at lowering intra-European tariff and quota barriers, cartels continue to impede a free economy and the volume of trade between European countries shows little signs of rising.

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But even if ECA accomplishes its historic task, Europe will still be a retarded area by comparison with the United States. By many great efforts, and with all the assistance that America can give, she has now roughly equaled her productive level of 1938, but since 1938 the productive capacity of the United States has more than doubled

The result is a Europe which has increased her productivity enough to require outside markets but not enough to compete on an even basis with the United States in those markets.

To lessen her need for food imports, Europe has to reform antiquated landholding systems and raise more crops on the same amount of land. To prevent a continued and catastrophic imbalance of productivity between the eastern and western hemispheres, she needs to adopt American industrial techniques.

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make money available to cover trade deficits incurred through the removal of tariff and import quotas. ECA hopes ultimately to see a Western Europe which is one great free-trade market of 250,000,000 people.

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yarn and woolen cloth are finding a significant market in the United States.

Technical aid to agriculture under Point 4 of course cannot cancel out economic and social abuses. In Europe as in Asia, a master key to a vigorous economy and the maintenance of a non-totalitarian political system lies in land reform. Landholding abuses have long provided a rallying point for Communists. More than any other one thing, say some students, lack of land reform was responsible for the Bolshevik success in Russia's 1917 revolution. The future of Italy may depend on the speed with which the De Gasperi government fulfills its promise to turn 3,750,000 acres over to the peasants.

The need for rural improvement is, if possible, even more pressing in Greece than in Italy. A team which surveyed the economic problems of Greece in 1947[2] returned with a report that she had but 1.31 acres of arable crop land per farm person. [illegible]

[illegible] der that the death rate in Greece today is 40 per cent higher than in the United States[1]

But even in unhappy Greece there have been vivid demonstrations of how goodwill, intelligence, and a very few dollars can work miracles of regeneration in crops and human beings alike. More than half of the country's livestock, for instance, had been destroyed in World War II. To increase the flow of milk, the Near East Foundation in 1945 resorted to artificial insemination. Six pure-bred brown Swiss bulls were shipped from America. The Foundation established insemination routes. Each morning an expert starts out with a supply of semen, stopping at preappointed rendezvous where peasant women wait with the cows that are to be bred. By the end of 1949 more than 25,000 healthy calves had been born to the six brown bulls.

[2] Smothers, McNeill, and McNeill, The Greeks (New York, Twentieth Century Fund, 1948)

country—having poured hundreds of millions of dollars into ending the civil war which symptomized the Greek disease—might not now balk at spending tens of millions in an effort to cure the disease itself.

TECHNICAL AID COMBINED WITH DOLLAR INVESTMENTS IN INDUSTRY

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increase

methods. Britain's Coal Conservation Committee has reported that judicious use of electric power could save 55,000,000 tons of coal a year.

Throughout Europe, factories are operating what Americans would consider to be barbarously low efficiency. Frequently

and would get more Reported Michael L. Hoffman in the *New York Times* late last year:

> Economists have calculated that before the first continuous strip mills were established in the United States the price of flat products bore a relation to the price of steel ingots of 225 to 100. After fifteen years this ratio was reduced to 119 to 100. The United States industry passed on practically all of the advantage of lower cost to consumers, and the consumption of flat products in the United States rose nearly 300 per cent during the same period, one steel expert said.
>
> It is generally agreed that Europe needs lower steel prices to bring down the whole range of costs of steel-using industries and to recapture its former 80 per cent of the world steel exports. . . . However, already there are signs that when the continuous strip mills come into operation in France efforts will be made to keep prices up a level that will main-

like the Tennessee Valley Authority in the United States. Sometimes such developments have as a primary purpose the production of hydroelectric power. This is the case with projects now afoot in the Scandinavian countries. Or they may be aimed at the reclamation of land, as in the Netherlands. Or as in the Monnet Plan of France they may combine many purposes in one—power, navigation, flood control, industrialization.

Many years ago, France bettered the welfare of tens of thousands of her citizens, and made room for tens of thousands more, by draining 2,500,000 acres of marshland and changing 500,000 acres of sand dunes to forests. The entire continent was better off because France was better off.

An even greater reclamation project—one familiar to every American school child—is Holland's Zuyder Zee enterprise, which has replaced salt ocean with bounteous farms.

Twenty-five per cent of the land in Holland lies below sea level. Forty per cent lies below the level of high floods—and the land is continuing to sink. As early as 1300 A.D. the Dutch were reclaiming land from the Zuyder Zee. The process has been described by the Czechoslovak author Karel Capek: "You take a bit of sea, fence it and pump it out, and at the bottom is left a deposit to which a respectable slice of Europe, by means of its rivers, supplies its best swampy soil, and the sea its finest sand, the Dutchman drains it, and sows grass there, the cows feed on it, the Dutchman milks them and thus makes cheese. . . ."[3]

By 1930 the Dutch at Wieringermeer had retrieved some 49,000 acres from the sea. The Urkerland Polder, more than *twice as large* as that at Wieringermeer, first became dry land in September, 1942

Two more reclamation projects, in the southwestern and southeastern portions of the Zuyder Zee, will bring the total reclaimed area of Holland to 550,000 acres, increasing her cultivated land by 10 per cent.

No less intriguing than the land reclamation in Holland is

[3]Quoted in Fresh Fields and Polders New, a pamphlet furnished by the Netherlands Information Bureau.

At Dongère Mondragon, on the Rhône River, a dam is under

of hydroelectric power to 3,000,000 kilowatts, while steam plants will add as much again. All told, the electrical energy available to France will be almost doubled. There will be more machinery in French fields, better equipment in French farmhouses.

A model for European development is the Aar valley of northwestern Switzerland. In the nineteenth century the Aarians lived in a primitive community, where the houses were thatched and wolves and wild boar roamed the hills. "The town of Rothrist," reports Morris Cooke, "cut down trees from the mountainside and sold the lumber in order to buy ship passage to [the United States] for its surplus and very poor population. It was shortly after this that the industrial development of Rothrist and the Valley of the Aar began. And while the three hundred voyagers who left the Aar to seek new opportunities in the New World were settling in the industrial slums of America, in many cases to remain there, the Aar valley was gradually being converted through considered industrial development to an area of social and economic abundance."[4]

The Aar development was made possible by the introduction of hydroelectricity. "Although the region is highly industrialized," adds Cooke, "it gives the impression today of a well-kept park. Factories, homes, and farms give every appearance of prosperity."

Americans have not the greatest per capita consumption of electric power in the world. Their consumption is equaled or

flowing water. From Swedish streams comes more than 90 per cent of her electricity, which already amounts to 2,060 kilo-

[4] "Plain Talk About a Missouri Valley Authority." *Iowa Law Review* (January, 1947).

At Dongère Mondragon, on the Rhône River, a dam is under construction which by 1952 will be supplying France from a 360,000-kilowatt installation. Dams at Ottmarsheim and Chas- [illegible] machinery in French fields, better equipment in French farmhouses.

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Americans have not the greatest per capita consumption of electric power in the world. Their consumption is equaled or surpassed by that of Norwegians, Swiss and Swedes, who live in lands of abundant waters and raging cataracts.

Sweden has no resources of oil or natural gas. Instead she has flowing water. From Swedish streams comes more than 90 per cent of her electricity, which already amounts to 2,060 kilo-

[6] "Plain Talk About a Missouri Valley Authority," Iowa Law Review (January, 1947).

The actual production in 1947 was less than 2,500,000,000 kilowatt-hours a year.

By 1950, however, the Finns had raised their supply of electricity nearly twofold. The Imatra Power Company was build-

20 power stations along the Kemi and Ii Rivers in northern Finland, regulating the supply of water by means of artificial reservoirs.

INTERNATIONAL CO-OPERATION

For fullest efficiency, development projects may ignore national boundaries. Power from the River Shannon, in Eire, helped to electrify most of Ireland as a result of common-sense, supra-political co-operation between Eire and the United Kingdom—two countries bitterly divided by both history and religion.

On the European continent as well, regional development projects can teach mutually suspicious nations a much-needed lesson in the benefits to be gained from acting jointly to create a more favorable physical environment.

Widely discussed is the proposal for a Rhine-Danube canal, which can speed the development of 76,000 square miles inhabited by 45,000,000 people in parts of France, Germany, Belgium, Holland, and Luxembourg. It can create realistic preconditions for a lowering of trade barriers. It can weld split and antagonistic sections into a natural geopolitical region, at peace by reason of its economic coherence.

It can do more. It can connect the West with Central Europe in a single great waterway flowing between Rotterdam on the North Sea and Constanta on the Black Sea—a waterway that some day may wash the iron curtain itself away.

The significance of the Danubian connection between West and East, between freedom and slavery, is difficult to overesti-

The financiers, the economists, and the politicians have been *working over Europe with* indifferent results ever since the end of World War II. The time has come to make room for the engineers.

13

Slave Europe — A Body Without a Head

IF EUROPE were a living organism, its greatest blood vessel would be the Danube River. In the 380,000-square-mile basin of the Danube 75,000,000 people live, breathe, and have their restricted being.

The Danube River is nature's great protest against Europe's

and friendly trade relations with the West.

Already the Danube provides an unmendable rent in the barrier which Russia has laid down between her satellites and the

A thousand years and more ago Charlemagne suggested that trade with the Orient would be quickened if the Danube were enlarged into a navigable waterway running all the way from the North Sea to the Black Sea. Ludwig I of Bavaria dreamed *of such a waterway in the nineteenth century. After World War*

one of the world's great cornucopias. It would not only expand transportation but increase the area's farm productivity, now

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IF EUROPE were a living organism, its greatest blood vessel would be the Danube River. In the 380,000-square-mile basin of the Danube 75,000,000 people live, breathe, and have their restricted being.

The Danube River is nature's great protest against Europe's man-made boundaries—against arbitrary state lines and economically nonsensical iron curtains. As long as the Danube flows, men will still hope for a federation of Eastern Europe—and friendly trade relations with the West.

Already the Danube provides an unmendable rent in the barrier which Russia has laid down between her satellites and the rest of the world. In Bulgaria, in Czechoslovakia, in Hungary, in Rumania, in Yugoslavia, it reminds subjects and rulers alike that in spite of man rivers still find the sea.

A thousand years and more ago Charlemagne suggested that trade with the Orient would be quickened if the Danube were enlarged into a navigable waterway running all the way from the North Sea to the Black Sea. Ludwig I of Bavaria dreamed ... After World War ... which would make ... by connecting the Rhine Meuse watershed with the Danube basin.

A united development project along the Danube could create one of the world's great cornucopias. It would not only expand transportation but increase the area's farm productivity, now less than half that of Western Europe. It would develop great quantities of hydroelectric power. It would raise educational and social standards. The processing of farm and forest prod-

11,500,000 tons of raw steel; we made more than four times as much. Her estimated production of shoes was around the 1940 level of 167,000,000 pairs—less than one pair per year for every
n. Livestock, much of which was destroyed by the invading Germans, remained well below prewar totals. Only in electric power, with an annual rate estimated at 75,000,000,000 kilowatt-hours, was she appreciably above 1940 levels: and United States production of electricity is about 300,000,000,000 kilowatt-ho

This is b
rise, or that
helm, of t
estimates,
the industrial and agricultural output of Soviet Central Asia went up 2.5 times, with a corresponding or greater improvement in conditions of health or education.

Projects of equal scope are now under way. A few of them:

1. Between 1924 and 1948 the Soviet Union planted 2,500,000 acres to trees. The postwar shelter belt program aims at ultimate afforestation of 15,000,000 acres—an area half the size of England—and protection thereby of more than 300,000,000 acres. State tree belts will extend nearly 4,000 miles,

for irrigation.

3. Typical of soaring Russian imagination and dogged Russian perseverance is the work of the Institute of Eternally

t is of the essence that private rather than public investment broad be America's keynote in Point 4.

Our Tennessee Valley Authority is a public corporation. It

ship—as it still is doing through irrigation and reclamation

was decided by states, by communities, by power boards—and by individuals. The Authority experts were available for consultation, but the local areas made the decisions.

In Russia and Eastern Europe, on the other hand, there is no private capital to rush through the sluice gates. Newly available power is used in fulfillment of ponderous governmental programs. It is turned into tractors but not into pleasure cars; into work boots but not into dancing pumps iforms

enter-

s work

the point is that it would make them faster and better and cheaper than government, with more consideration of the working men and women involved, because competitive private enterprise has to be

on that an imminent and catastrophic western depression
would force a resumption of East-West trade on terms laid
down by the East. If there is no such depression, it is hard to
see how Russia can avoid making gestures in the not-distant
future that are aimed at putting at least a semi-colon, if not a

they will provide no competition for American men and machines. And when they do accept it, they will no longer be Communist.

conomic, social, health, and related problems and international cultural and educational co-operation."[2]

ternational civil servants was set up to receive, sift, schedule, and act upon requests for aid from underdeveloped countries. Expenditures were forecast at $100,000,000 over a two-year period. For lack of organization and technicians, the initial expenditures will probably be considerably less than that amount.[3]

Co-operation between different UN agencies was already a commonplace in 1949. "The World Health Organization and the United Nations Educational, Scientific and Cultural Organization," reported the Secretary General, "have worked together

control and food production in South Asia. Personnel from

practices and achievement of financial stability in particular

...xico, Brazil, Belgium, Finland, the Netherlands, India, Columbia,

... purely an agency of the United States Government.
... number of developmental loans, it was originally
... with the rest of the world. Its authorized capital
... standing loans, credits, and guarantees may not
...

economic, social, health, and related problems and international cultural and educational co-operation."[2]

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FAO are currently laying the basis for a joint project for malaria

practices and achievement of financial stability in particular

exceed three and a half times that amount. guarantees may not

ck of good sense, not from lack of instrumentalities for avoid-
ng them.

isen to them. Today, when he has attained at last the god-like power to choose between his own destruction and his own salvation, there is good reason to hope that he will rise to the challenge again.

16

Machines and Money

days off to boot.

Small wonder that Charles E. Wilson of General Motors has quoted an economist as saying, "A hundred years from now our standard of living can be 16 times higher than it is today. That sounds like a lot; but if you break it down, you will find that it amounts to a little less than 3 per cent compound interest.

even minor changes continue to be met with unco-opera howls of 'socialism,' our system is apt to grow unhealthily ri which will mean that we have become unable to adjust ourse to changing technologies and conditions."

Private enterprise in the past century gladly accepted 1 000,000 acres of public land for western railroads; and 2 000,000 acres which went for nothing or for little more t nothing to farmers, ranchers, and timbermen; and tariffs to tect American goods from foreign competition. Private en prise in the present century has not been reluctant to ac subsidies for airlines, farming, shipping, and other socially ful works. Private barges are glad to use federally mainta inland waterways, and private trucks and buses are glad to tr along highways built with tax dollars.

Though for a long while industry denounced as social such reforms as the income tax, or the eight-hour day, or al tion of child labor, in the end it accepted them—and was al better for it. Today the American income tax alone amoun as much as the total Russian income—and America remai capitalist country.

There are circumstances under which government investi is a spur to private investment. Government is more likely business to provide the money for transportation and comm cations, sanitation, roads, harbors. Social security and river ley authorities in the United States represent two shifts in relationship between the government and its people which still new enough to be denounced in some quarters as social. Actually, they are part of what *Fortune* magazine calls indispensable framework for the release of private initiati That framework is not the same today as it was a quarter century ago, or as it will be a quarter of a century from now, its purpose remains unchanged.

The continuing capacity of private industry for acceptin and sometimes initiating—reform can be measured by a c parison of working conditions today with those of forty or t twenty years ago. Its capacity for breadth of vision has l

even minor changes continue to be met with unco-operative howls of 'socialism,' our system is apt to grow unhealthily rigid, which will mean that we have become unable to adjust ourselves to changing technologies and conditions."

Private enterprise in the past century gladly accepted 180,000,000 acres of public land for western railroads; and 200,000,000 acres which went for nothing or for little more than nothing to farmers, ranchers, and timbermen; and tariffs to protect American goods from foreign competition. Private enterprise in the present century has not been reluctant to accept subsidies for airlines, farming, shipping, and other socially useful works. Private barges are glad to use federally maintained inland waterways, and private trucks and buses are glad to travel along highways built with tax dollars.

Though for a long while industry denounced as socialist such reforms as the income tax, or the eight-hour day, or abolition of child labor, in the end it accepted them—and was all the better for it. Today the American income tax alone amounts t as much as the total Russian income—and America remains capitalist country.

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Conclusions

We have the paradoxical situation that those countries which can afford to start with investments of such magnitude have little or no reason to change their food habits. The one exception is Japan where the need for food is pressing, labor is cheap, and at the same time industrial skill is highly developed. In Japan, too, the acceptance of algae as food will not encounter great resistance since the population is accustomed to eating some of the larger algae taken from the ocean. . . .

It is, of course, impossible to predict how soon the countries of Western Europe will become either so poor or so overcrowded that dairy products will no longer be available. In this event, the groundwork has been done with which to produce a reasonable substitute. As things stand at the moment, it appears that the so-called underdeveloped areas and the ancient countries of the East, where the food problem is acute, are not yet ready to start on their own initiative with an industrialized food production in the manner outlined above, particularly in view of the fact that the older means of improving crops have not been exhausted.

What, then, should be done? It is a fascinating and perhaps urgent problem to find out how to convert our daily supply of solar energy into chemical energy, useful in many ways, for many purposes. Since at present only the plants can do this efficiently, studies of the growth and photosynthesis of algae should be encouraged. It is one thing, however, to promote this type of research because it is fundamentally important, and another to believe that success along this line will solve the terrifying population problem.

Pessimists are everywhere disliked no matter how well-established the facts are on which they base their dour predictions; their warnings as to the increasing urgency of the problem posed by the faster and faster exploitation of natural resources and an ever-increasing human population are either ignored or seemingly refuted by pointing to the progress reports of the specialists In the case of our algae, what the specialist can readily predict is merely that mass cultures of these organisms will be introduced wherever an acceptable product can be sold

at a profit and that this will not happen in many countries during the next twenty years. During these twenty years the population of the United States alone will have increased by over forty million, and on the earth as a whole—if no hydrogen bomb interferes—by more than half a billion. Despite some technical progress, the enormous problem of adequate food for all will very likely have become more pressing than ever. . . . *It is time to acknowledge publicly* (and not shyly in one half sentence of the specialist's summary) that it is not possible to solve the population problem by way of an ever-increasing food production alone. We must have *populations in balance with* the area from which they can be easily fed. The reporter of the *future will certainly hail it as a great achievement when our* crowded great-grandchildren shall subsist contentedly—because they know no better—on hydrolyzed sawdust and predigested, vitaminized algae. But we, should we not rather strive to preserve for them conditions where they may still be able to find *a garden in which to pick fruit from a live tree?*

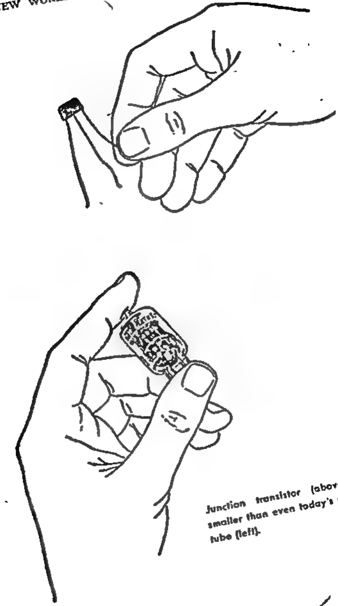
LEONARD ENGEL

Little Gadget with a Large Future

Previous articles in this anthology have reported on a few of the accomplishments of the vacuum tube, the ubiquitous gadget that brought the electronic age and that has been described as the most revolutionary invention of the past century. Here is a report on the transistor, the tiny device that promises to take the place of the vacuum tube (in most uses) and to carry the electronic age farther than anyone now dares dream. The article is reprinted from Harper's Magazine for March, 1952. Illustrations are reprinted by permission of Sigman-Ward.

In July, 1948, the *Physical Review*, the almanac of physics, published three short papers from the Bell Telephone Laboratories. The first, by John Bardeen and Walter H. Brattain, began: "A three-element electronic device which utilizes a newly-discovered principle involving a semi-conductor as the basic element is described." Thus was announced, in deceptively restrained language, an invention which may change our way of living more than atomic energy. The invention is the transistor, a device which performs about the same functions as a vacuum tube but is so much more convenient that it is destined to superimpose a new technological revolution on the already very revolutionary branch of technology called electronics

To begin with, the transistor is much smaller than the vacuum tube. One model is about half the size of a pea and smaller ones still can easily be made if they are wanted. Further, there is no vacuum and no glass envelope, no filament to burn out,



Junction transistor (above) is much smaller than even today's small vacuum tube (left).

Hence transistors should last almost indefinitely; transistors probably capable of operating continuously for more than 100,000 hours (over eleven years) have already been made in the laboratory. Finally, the transistor consumes vanishingly small amounts of power and generates almost no heat. These two properties alone make the transistor invaluable, for it appears that two of the principal obstacles to new electronic wonders have been the large amount of power required and the heat given off by the vacuum tube.

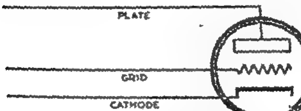
Dr. Louis Ridenour, dean of the University of Illinois Graduate College, predicts that the transistor will make possible computing machines with a hundred times as many computing elements as any calculator now in existence and, for problems within their grasp, a tenth as competent as the human brain. The transistor may also bring into being the elaborate electronic control systems which, we have been told, are ready to take over many of the intricate but tedious tasks of an industrial society, but which never got off the ground in the vacuum-tube era: the all-electronic record-keepers, the robot inventory and warehouse control systems, automatic centralized control for air and rail traffic, automatic utility meter reading and billing, and so on. This super-compact, durable successor to the vacuum tube likewise has obvious applications to military electronics. On a homelier plane, the transistor promises telephones with built-in amplifiers, matchbook-size hearing aids capable of running for several years on a single set of batteries, really small portable radios, TV sets whose "tubes" will never need renewal (except for the picture tube, which is a relative of the X-ray tube and not a conventional vacuum tube at all, and therefore won't be replaced by the transistor). And, of course, the transistor will bring contrivances and gadgets that cannot now be imagined.

II

The device that is to accomplish all this is a sort of educated cousin of the old crystal detector, which Father used in the headphone radio set he built when he was a boy. Like the crystal detector, the transistor makes use of the special electrical prop-

filament and the plate. All the variations in the smaller current were impressed upon the larger, making the latter a faithful, but much enlarged, replica of the former.

This was the three-element vacuum tube, or audion, as De Forest called it. The audion was soon at work amplifying long-distance phone calls. Nothing much else was done with it for several years, however, until the invention of the regenerative circuit (the first practical radio circuit) by a Columbia undergraduate, Edwin H. Armstrong, who was later to invent FM.



The principle of the vacuum tube is still essentially the same as in de Forest's audion. The flow of electrons from cathode (filament) to electrode (plate) is controlled by a much smaller current in the mesh of fine wire grid.

The vacuum tube has since proved to be one of the most fruitful inventions in history, the source not only of an astonishing array of other inventions, but of some of the most torrid patent battles on record. One was the battle between Arnold of A T & T and Langmuir of General Electric over high vacuum, which greatly improved the vacuum tube. Another, the celebrated struggle between Armstrong and De Forest over the regenerative circuit, led to the longest, bloodiest patent suit in United States court annals.

Since De Forest's day, the vacuum tube has undergone innumerable changes and permutations. There are now tubes with four, five, six, and even seven or eight elements, to attain vari-

imity fuses, electronic gun- and bombsights, and military communications. We would possibly be better off without the latter, but essentially similar tubes are required for air and marine navigation, and also perform hundreds of other jobs which contribute substantially to our well-being, from curing rubber and plastics by high-frequency induction heating to checking the labels of drug bottles. Last but not least, vacuum tubes are the sensitive eyes and ears of science, and can do much of its routine brainwork. The electron microscope makes visible the infinitesimally small; action-potential apparatus tunes in nerve impulses; electronic controls regulate atom-smashers; electronic computers whip through the unbelievably tedious mathematical equations which seem to arise from even the simplest research problems.

But paradoxically, the vacuum tube, which made radio and electronics possible, has become an obstacle to further progress. There are two chief difficulties The first is that the vacuum tube is inherently short-lived and unreliable. The second is, that the vacuum tube, in Dr. Ridenour's phrase, is the grandchild of the electric light bulb. It was originally conceived as a hot wire inside a bottle and, like its progenitor, it requires a large amount of power to operate and thus dissipates a great deal of heat.

The vacuum tube is a self-consuming device. As in the ordinary light bulb, the heated filament (or heating element in tubes that employ indirect heating) is bound to fail sooner or later. Of course, the filament can be made heavier, but then a larger current will be needed to boil off electrons. The problem is compounded by price competition in the tube industry. Manufacturers have performed prodigies of ingenuity in the fabrication of vacuum tubes, but the primary object has been to cut costs for the mass radio and television market. Vacuum tubes, consequently, are not as carefully made or as dependable as they might be, most have a useful life of only a few thousand hours

This is not a serious matter in an inexpensive six-tube radio set. It is quite inconvenient, however, in a TV set with twenty-five to thirty-five tubes, where the chance of set failure as a result of tube failure is multiplied by five, and where an expen-

vacuum-tube equipment cannot be pushed. Aside from the difficulty of fabricating and assembling very small components, there is the circumstance that miniature tubes of comparable performance have the same power requirements as standard tubes and therefore dissipate just as much heat. The National Bureau of Standards, for example, recently worked out a miniature edition of the standard aircraft radio range receiver. The miniaturized set has less than one-fifth the bulk of the standard receiver. Both, however, consume roughly the same amount of power, some thirty watts. In the miniature range receiver, this results in the dissipation of heat energy at a rate equivalent to a tenth of a watt per cubic inch—just about the rate of energy released in a kitchen oven. The temperature inside the miniature range receiver accordingly may reach four hundred degrees Fahrenheit.

If the temperature were to go higher, it would soften the glass in the tube envelopes. As it is, high-melting-point solders must be used for connections, greatly increasing the tediousness and cost of assembling miniaturized equipment. More serious, the excessive heat shortens the life not only of tubes, but of other components of the set, adding materially to the chances of set failure.

IV

The difficulties that have made the vacuum tube a troublesome, if remarkably versatile, tool of technology are neatly avoided by the transistor. Like the vacuum tube, the transistor (so named because it transfers an electric current across a resistance) imposes the pattern of one current on another; thus it can also be employed to amplify a current or generate a radio signal, or as a relay. In the new device, however, electrons are not boiled out of a filament, the current flows through a crystalline solid.

This indeed sounds something like the crystal detector of radio's early days. The transistor, in fact, grew out of a rebirth of the crystal detector. During the war, it was found that the two-element vacuum tube detector used in standard radio wouldn't do for radar. The crystal detector proved much more

rough the crystal as the insufficient number of electrons dance out in a futile attempt to fill the vacancies. Most remarkable all, the flow of electrons and holes can be controlled by a urrent applied at barriers between electron-rich and electron-ficient regions, in much the same way as the flow of electrons through a vacuum tube is controlled by the current in the rid.

Of the two key men in the group that worked out this picture f what happens in semi-conductors, one had just turned forty: ohn Bardeen had come to the Bell Laboratories from the University of Minnesota and the Naval Ordnance Laboratory after the war. Walter H. Brattain, a few years his senior, had spent most of his professional career as a Bell Labs physicist, studying the flow of electrons. Dr. Bardeen, in particular, is credited with important contributions to the underlying theory, which not only threw new light on semi-conductors but led Drs. Bardeen and Brattain to concoct a revolutionary device for exploiting them, the point-contact transistor. The latter, the first tool of the new era in electronics, is a little larger than the eraser on the end of a lead pencil. It contains, inside a simple cylindrical metal case, two hair-thin wires—"cat's whiskers," in radioman's language—resting on a small piece of germanium soldered to a metal disk. When properly connected, a signal put into one cat's whisker comes out through the other amplified one hundred times

An even simpler type, the junction transistor, was developed by Dr. Shockley last year. The junction transistor is a germanium rod perhaps a tenth of an inch long in a plastic case half as large as a pea. Exceedingly minute impurities have been introduced to make the ends of the rod electron-rich and the center deficient in electrons; the electron-rich ends serve as "filament" and "plate," the electron-deficient center is the "grid." A wire from each section of the rod completes the transistor assembly.

V

Beside simplicity and small size, the great advantage of the transistor is the fact that the electrons and holes are lying about loose inside the crystal, ready to go to work. No energy is needed to boil them out of a filament. As a result—to men-

of power of very little more than a millionth of a watt. Bell Labs has a demonstration junction transistor circuit which can operate on the energy picked up by a photoelectric cell held in front of a white shirt, about six ten-millionths of a watt—the energy expended, a Bell lecturer has calculated, by a flea jumping once every eight seconds. As the amount of energy wasted on heat will be negligible even in powerful transistor circuits, transistors may be packed as closely as we please in miniaturized equipment, without any danger whatever of overheating.

The transistor is not ready for immediate assumption of the vacuum tube's many roles. Its new properties call for new circuit arrangements, which will take at least a little time to work out; present-day radio represents not only four decades of tube design but four decades of circuit-making. The most powerful transistors made thus far, furthermore, have a signal output of only two watts, roughly a fifth of the power needed to operate a loudspeaker. Also, the junction transistor, which has the most desirable characteristics in other respects, cannot in its present form handle shortwave, FM, or television frequencies, and hence can be used only for special purposes in such equipment.

Nevertheless, the new era in electronics is at hand, for equipment based on the revolutionary Bell device will soon be in production. A key part of the new long-distance dial telephone system will be an automatic route selector based on a phototransistor, a combination of photoelectric cell and transistor, for "reading" and "translating" coded intercity telephone route cards. General Electric, RCA, Sylvania, and other major electronics companies, moreover, have active transistor research and development programs. GE is near production of a device closely related to the transistor, the n-p diode, which promises to be the simplest and most efficient means yet devised for converting alternating to direct current. One model, about the size of a large olive, can put out enough direct current for a row of aluminum refining pots or electroplating baths; a handful of them can replace an entire roomful of rectifiers. Were it not for defense delays, another type of n-p diode would have gone into GE's 1952 television sets instead of the rather inefficient selenium rectifiers now used in most home radio receivers for converting the house AC supply into the DC needed by the

E. W. LEAVER and J. J. BROWN

Machines Without Men

The last few years have seen a rush of technical and popular articles on a portentous development that may have as great effects on life in the remaining decades of the twentieth century as the Industrial Revolution had on life in the nineteenth. The development is "automation," the application of automatic controls to manufacturing and to an ever-increasing variety of other tasks, from keeping inventory to the recording of phone calls and preparation of phone bills. Many of the ideas now being discussed go back to an article that appeared in *Fortune Magazine* a decade ago (issue of November, 1946). The article was "Machines Without Men"; its far-sighted authors were two Canadians, E. W. Leaver, an electronics engineer, and Dr. J. J. Brown. "Machines Without Men" is reprinted here in condensed form by special permission of the editors of *Fortune*.

Imagine, if you will, a factory as clean, spacious, and continuously operating as a hydroelectric plant. The production floor is barren of men. Only a few engineers, technicians, and operators walk about on a balcony above, before a great wall of master control panels, inserting and checking records, watching and adjusting batteries of control instruments. All else is automatic. Raw materials flow in by conveyor, move through automatic inspection units, fabricating machines, subassembly and assembly lines, all controlled from the master panels, and arrive at the automatic packaging machines as finished products—radios, refrigerators, tractors, fountain pens, carburetors, he[illegible] what you will.

[illegible] from the pres-

[illegible] ic plant is

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automatic insp

and assembly

arrive at the a

—radios, refr

it for repeated use. Common examples are the office Dictaphone, all manner of punch-card systems, perforated tape, and recordings on plastic, paper, wire, and film. The last type of information unit is one that calculates. Examples range from the adding machine and other business machines to the new [illegible] known as ENIAC.

[illegible]

machine units and the [illegible]

The third class of machine unit is that which performs an actual manufacturing operation. These operations may be subdivided into three types.

The first is *transport*, i.e., all sorts of moving and carrying, [illegible] rotary, or reciprocating motion. The mate- [illegible] The second funda- [illegible] operations on [illegible]

[illegible] work and tool move (surface grinder, thread-cutting lathe, tool-post grinder, thread grinder). In each instance the holding is as important as the cutting.

[illegible] mechanisms are [illegible]

... Common examples are the office Dicta-
... tape, and
... type of
... from
... the new
electronic-tube counter known as ...

The second class of basic machine unit, the collation-and-control device, is a chassis of electronic tubes and circuits that accepts information fed into it by information units and in turn feeds controlled power to the operations units in accordance
... machine compares
... if they do not
...

actual manufacturing operation. ... divided into three types.

The first is *transport*, i.e., all sorts of moving and carrying, whether by pushing, rotary, or reciprocating motion. The mate- ... be solid, liquid, or gaseous. The second funda-
... on
... to the
... punch-
... assembling, ... final
...

tool-post grinder, thread grinder). In each instance the holding is as important as the cutting.

power to start the hand-arm and fabricating machines.

The central fabricating unit for this type of operation might be an automatic lathe with standard spindle to hold and rotate the material, a compound rest to hold the threading tool and direct it in making the cut, and two hand-arm machines to handle material, change tools, and perform the final milling operation and cutoff. Brass tubing feeds in automatically through the headstock. The power fed to the machines is determined by the control impulses sent down from the master record, and its duration is controlled by the length of perforations in the record roll. The timing of the machine operations is determined by the position of the perforations relative to one another. The record moving through the rack causes everything to take place in orderly procession. During fabrication, tools may change in the holding fixture, the position of the work in the holding unit may change, and speeds of rotation and feed will change.

As soon as any hand-arm or fabricating machine moves, detector devices go into action. These are an integral part of the unit, mounted to "watch" every critical operation. One such device might be a detector to pick up excessive vibration in the lathe spindle. It consists of a detector head clamped to the lathe and connected by a circuit to a basic information unit on the floor beside it—an electronic chassis composed of a standard power pack, amplifier, and distributor panel plugged into one another to form a single unit. The pressure head detects changes in pressure (vibration) at the spindle and converts them to electrical impulses. The amplifier increases their power and feeds them at standard impedances and power levels to the distribution panel, which sends them to the collation-and-control unit. At the slightest increase in vibration, the collation unit adjusts the power to the lathe spindle. One or more detector devices may be connected through the information unit to the collation unit, which constantly compares their impulses with the standard impulses coming from the master record and accurately regulates the whole operation.

At the end of the cycle the finished brass ring is dropped on an outgoing conveyor belt, where it passes an informational unit equipped with detectors to inspect its shape and dimen-

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At the end of the cycle the finished brass ring is dropped on an outgoing conveyor belt, where it passes an informational unit, equipped with detectors to inspect its shape and dimen-

off onto another conveyor that takes them to either shipping or salvage. Materials that pass inspection are fed by conveyor to warehouse bins or directly to the production machines. The finished parts pass from the production machines through another inspection, to subassembly and assembly machines.

The assembly machine, another kind of production tool, again employs the hand-arm type of unit, working over an assembly jig, controlled by a master record. The first part needed for an assembly is picked off the conveyor and placed in the jig. Having operated once, the hand-arm that supplied this part cannot work again until it is triggered. When the parts have been assembled in a jig, a riveting, welding, or induction heating device darts in to fasten them together and the finished product is ejected. For most products a moving line of assembly jigs would probably be used, with a radial system of conveyors feeding in completed parts and subassemblies.

In such a factory the human working force is confined to management, which makes the policy decisions as to how many of what items to produce, and an engineering and technical staff, which carries out the decisions. If a product is to be changed, new specifications for a new product in the form of punch cards or blueprint records are substituted for the old in the master record-control racks. Teams of technicians go down on the production floor to rearrange, set up, and reconnect the interchangeable units of production. Then the continuous production run is started again.

An economy that makes full use of such production machinery will be so different from the present it will constitute a new industrial order. The advantages to management are, perhaps, obvious. Higher volume and cheaper goods are immediately discernible. The production rate will be higher, not being limited to human considerations anywhere in the chain. The production rate will also be constant and continuous, permitting a close figuring of costs. Both man-hour and machine-hour production rates will be incomparably higher, and consequently g[illegible] will be cheaper. They will also be better, because the [illegible] precision in manufacture,

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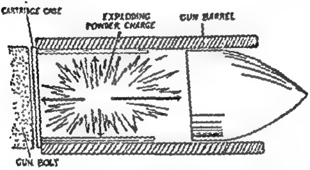
matic factory may well loose waves of temporary unemployment. But the long-range benefits are hardly to be contested. It is better to regiment machines than men. The whole trend of present automatic controls and devices applied to present production machines is to degrade the worker to an unskilled and tradeless nonentity. The development of completely automatic production lines would reverse this by demanding a highly skilled force of technicians and operators. The astonishingly rapid development of new skills and occupations under the pressures of war shows that men are up to it. By the use of training programs, a shorter work week, and other devices, the shocks of transition could be cushioned. Here for the first time we have a production system so potentially efficient that the two-or-three-day week is economically feasible. This system is designed to supply a mass market, and without the mass market it would be worse than useless. Its cheaper costs could be passed on in higher wages to the worker and greater value to the consumer. It must, therefore, balance out at a higher level of living than ever before.

Many of the ills of modern industrial society can be traced in large part to the regimentation of workers and other materials that do not take kindly to it; and the failure to regiment machines that are ideally suited to it. Our present industrial system tends to regiment the worker and destroy his skills and initiative, without a compensating measure of economic security. Regimentation of machines cannot hurt the machines, and can emancipate the worker forever from degrading or monotonous toil.

under intense study.

An intercontinental missile might be achieved in either of two ways. It might be what aeronautical engineers term a cruising or flightpath missile, or it might be a trajectory missile. A flightpath missile is essentially an unmanned airplane. Soldiers sta-



WHY GUNS RECOIL

Gas from exploding powder charge pushes in all directions. Gas pushing up offsets gas pushing down. Gas pushing forward drives bullet out of gun barrel, then escapes. Gas pushing back drives cartridge case back against gun bolt, making gun move back or recoil.

tioned in England during the last year of World War II were well acquainted with flightpath missiles. The V-1 buzz bomb was one.

Like most airplanes, the flightpath missile takes off at a s... wings to support it; and it is propelled by an "air- ... that depends on an outside ... missiles ... plest, cheapest type ... e mission.

Flightpath missiles fly at relatively low altitudes (because of the need for air) and at relatively low speeds; they can be inter-

rearward thrust drives the gun against the shooter's shoulder. In a rocket, the opening of the combustion chamber is to the rear. So rearward-expanding gas escapes, while the gas pushing forward presses against the *forward* wall of the chamber and "recoils" the rocket forward.

It is often thought that rockets are driven forward by the push of escaping gas against the air behind the rocket. This is not so. If it were, rockets would not work in a vacuum. In fact, they work better in a vacuum than in the air, since the escaping exhaust gases are not slowed down by air resistance and since the drag of the air on the rocket itself is eliminated.

In signal and Fourth-of-July rockets, the usual propulsive charge is a gunpowder-like mixture of sulfur, charcoal, and saltpeter. The sulfur and charcoal represent the "fuel," while the saltpeter furnishes the oxygen. In modern military bombardment rockets, the propelling charge is a "stick" of smokeless powder which also burns without the need of oxygen from the air.

All rockets that burn a "gunpowder" of some kind are known as solid-fuel rockets. Curiously, for some time the largest solid-fuel rocket was an airborne rocket designed to be fired against ground targets. Nicknamed Tiny Tim, it was 10 feet 3 inches long and weighed 1,284 pounds. A more recent solid-fuel rocket, Honest John, an Army missile meant to be used from the ground like heavy artillery, is even larger.

Large as some are, solid-fuel missiles are dwarfed by liquid-fuel rockets. As their name states, the latter carry a liquid fuel and a liquid oxidizer in separate tanks.

To keep their weight down, really large liquid-fuel rockets have thin skins. Consequently, they cannot be fired through an aiming tube (the tube would tear their skins off), but must be stood on their tails for a vertical take-off. Thus, large rockets [illegible] be described from top to bottom rather than nose to [illegible] nose and tail are retained. [illegible] the payload [illegible] site, an "instrumentation cone" for [illegible] ack observations on conditions in the stratosphere if it is a research rocket. Next

d) the exact distance from the take-off point, and

e) the exact distance from the ground at the moment the fuel is cut off.

Even a small error in any of these calculations (not to mention unknown winds and so on as the rocket approaches the target) will lead to an impact miles away from the target point simply because of the great distances involved. If the deviation of actual impact point from the theoretical target point is expressed as a percentage of the range, one finds—not counting cases of obvious malfunction—that the V-2 was nearly as accurate as a field howitzer. But since it was fired over a range of 200 miles and climbed to a height of more than 60 miles along its trajectory, V-2s scattered over the whole area of metropolitan London. It is interesting that the Germans, foreseeing such scatter during practice firings, placed their observers right at the theoretical target point. Just as expected, the men were close enough to the impacts to observe them, but no rocket fell closer than 1,000 yards. It is clear that guidance will remain the main problem in trajectory missiles, and new trajectory-missile guidance devices the most closely guarded secret, for years to come.

While little has been said about actual progress in long-range military missiles, in the field of high-altitude shots every record established has been broken soon afterwards. In 1943, a V-2, fired on a near-vertical trajectory, reached an altitude of 100 miles. In December, 1946, a captured V-2, fired from the White Sands Proving Ground in New Mexico as No. 17 of the U.S. V-2 high-altitude [illegible]

miles [illegible]

side th[illegible]

August [illegible]